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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XXI.—No. 527.

THE RISE IN COPPER.

THE aspect of the great copper question is not reassuring. In fact it is even more gloomy than it was a week ago. We now know, with some degree of certainty, what are the causes of the present unprecedented high price demanded for copper in all forms. An exceedingly strong "corner"—the word "syndicate" is repudiated—has been established in the French capital, and agreements have been entered into which insures for it the necessary financial support to maintain the price of copper for a period of not less than two years. The Sociëté des Metaux and certain powerful bankers and credit establishments are the component parts of this "corner." Most of the French papers have denounced in unmeasured language the conduct of the parties to this extraordinary arrangement; but there are not wanting journalists who defend them, claiming that they have benefited trade instead of injuring it. A few extracts from Parisian journals, however, will show pretty clearly what the general feeling is in France with regard to the corner, rig or conspiracy.

The *Justice* publishes a long article, in which it says:—"The barons of finance have bought up all the copper, which is now sold at the price of gold. After the copper, the turn of iron, silver and gold may come, and the smallest quantity of metal will no longer be received in France without the permission of a few big speculators." After quoting an announcement in another paper concerning the formation of a syndicate, the *Justice* proceeds:—"In plain words this means that all the industries employing copper, from the marine to the manufacturer of cartridges, are to be for two years at the mercy of that syndicate of monopolists who have just withdrawn copper from commercial circulation." The *Justice* will not admit that the fact of the copper mines not being on French soil can place the monopolists beyond the reach of the law. It says:—"If the mines on which they operate are not on French territory the market which receives this mortal blow is in France, and we are not aware that the Penal Code has ceased to be applicable against speculators who, by coalition, have attempted to fetter commercial liberty, and to give to goods by monopolising them a value they do not really possess. The speculators in question have not only attempted, but succeeded." The *Lanterne* is even more violent, and after demanding the immediate prosecution of the monopolists, it adds:—"The present case shows the danger entailed by those immense fortunes of which the Monarchies allowed the foundation, and which give to private individuals the power of a Government and the irresponsibility of a private man." The *Paris Bourse* may be taken as representing those who entertain views and opinions the opposite of those enunciated by the papers we have quoted. It triumphs in the success which has been obtained, and adds:—"Thanks to the sagacity of the leading minds in France, French metallurgic societies can now confront universal competition. Those who have been at the head of the metal movement deserve the thanks of the whole business world. The rise in the price of metals has brought with it a general revival of commerce. Chemical products, which, according to the celebrated axiom of Lord Beaconsfield, are the barometer of commercial prosperity, have risen more than 30 per cent." It is remarkable that this view of the position is not upheld by any influential paper, either in France or in England; the most prevalent assumption is that all who are outside the ring will suffer from the consequences of its monopolistic *coup*.

To quote the words of a French deputy: "The new copper syndicate is playing with fire in a crowded and, financially speaking, hampered country with revolutionary predilections." The *Daily News* Paris correspondent says the rise in copper is already a source of considerable distress in the busy quarters, and directly or indirectly affects all industries, but none more than those connected with the national armament. The same authority states that means are being taken to force the Government, when the Chamber meets, to take action against the syndicate, or whatever the combination chooses to call itself. The letter and spirit of French legislation are hostile to concerted action having for its object to check freedom of sale or of purchase; but whether the law and public opinion are strong enough to intervene and disperse this irritating alliance remains to be seen.

The other contributory to the present artificial position in regard to copper, the fires in the Hecla and Calumet mine, is not less unsatisfactory. The latest information adds to the misgivings previously entertained, and it is conjectured that the mine may not be reopened for months. Flooding has been spoken of, but whether that heroic measure will become absolutely necessary seems at present a matter of doubt. It cannot be said that the fires in this mine had any part in originating the rise in copper, but they have certainly greatly intensified the increase to fictitious values—values which are not yet stationary, for we have just received an intimation from a prominent manufacturer that the price for copper wire of all kinds has advanced ¾d. per lb., plain 0/20 being now 1s. 0¼d. per lb., and tinned 1½d. per lb. extra.

CURATIVE ELECTRICITY.

A LETTER in the REVIEW of last week, followed by another in to-day's issue from the pen of Mr. Lynd, brings us to the conclusion that it is high time the public should be made aware of the fact that all things are not what they seem. For many years past the mysterious nature of electricity has been made the means of perpetrating a series of frauds upon the unsuspecting populace, and electricity as applied to curative purposes has, perhaps, been the greatest fraud of all. The number of persons trading upon the credulity of the people in this one branch alone is considerable; but how are they to be suppressed? All we can say, and all we can do, will not avail one jot. Technical journals do not as a rule circulate amongst those who are most easily gulled, but, inasmuch as our remarks may be reproduced here and there, we will briefly relate one or two circumstances in connection with the medical electrician's calling which have just come under our notice.

First we have a specimen of a galvanic generator, which is made thus: A small oval frame of a bituminous nature contains a similarly shaped but smaller zinc plate ornamented in relief with "lightning flashes." Placed on this is a copper disc of similar shape, without any separating medium whatever between them. The combination is perfectly dry, and we need scarcely say that the apparatus sent to us is absolutely useless. The second is a magnetic appliance which may be a so-called chest protector, or anything else. Sewn up in a semi-circular piece of silk we find twelve feebly magnetised pieces of crinoline steel, and this is all; yet the price of the article is said to be thirty-five shillings.

No man of ordinary education could believe that such devices as these can possibly effect any good in the human system, yet, if we may judge from the advertisements of such goods, the sales must be enormous, and the vendors of these articles grow rich at the expense of weak-minded and highly imaginative individuals. We know that electricity properly applied by a qualified practitioner is efficacious in many ailments, and numerous genuine cures are on record which have been entirely due to the galvanic current; but it must be remembered that electrical treatment may in some cases produce harmful results. We are also aware that a French physician is said to have effected marvellous cures by working upon the imaginations of many of his patients who were inclined to place implicit faith in the virtues of magnetism. The Frenchman simply employed pieces of wood shaped like and made to represent magnets, and with these simple and absolutely harmless objects he effected his purpose.

Knowing this, what good cause could we serve by naming any of the gentry who so successfully trade upon the credulity of the public? We have no doubt about the worthlessness of the apparatus palmed off in the majority of cases, neither have our readers; but if it ever became necessary to bring this matter into a court of law there is every reason to believe that many persons would be found willing to come forward and swear that they had derived incalculable benefit from the use of these so-called curative electrical appliances. This being the case, we do not see how the trade can be rooted out, or even diminished.

THE Mayor of Birmingham, Councillor Pollak, is a warm supporter of electric lighting. He was for some years chairman of the Birmingham Gas Committee, and he asserts that one of the reasons why he desired to become a member of that committee was that he had visited the Paris Electrical Exhibition, and there formed the opinion that it was not necessary to supersede gas altogether, and that it would be possible some time to work the two lighting agents together. This statement was made in an address to the students who attend the evening classes organised in Birmingham for the spread of technical education, and his object was to advise his hearers to do their utmost to acquire a knowledge of the principles and applications of electricity. It is interesting to learn that he believes, notwithstanding the difficulties created by the Electric Lighting Act, that under certain circumstances it would be to the advantage of the Corporation of Birmingham to itself undertake the installation of electric light in large buildings, or in some of the large squares; curiously, however, he does not believe the electric light will ever be a success in streets. We hope he may have cause in his own town to alter his opinion upon this point.

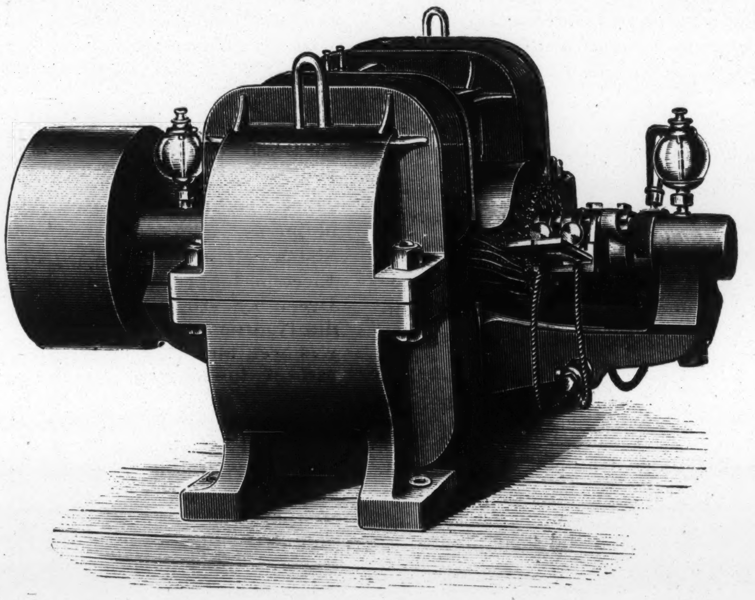
THREE fatalities arising from contact with wires conveying electric currents have come under our notice during the week just past. One is near home—at Risca, in Wales. The account which has reached us is meagre. It runs thus:—"A man named James Williams, of Ebbw Vale, was yesterday [last Monday] morning instantly killed by an electric shock at the Pontymister Tin Plate Works, Risca." There are many points upon which we should like to be informed as to the exact manner of this poor fellow's death before expressing any opinion with regard to the sad occurrence; perhaps some of our Welsh correspondents will oblige us. The other deaths occurred in the United States. Mr. Elmer E. Wood, of the Canandaigna (N.Y.) Electric Light Company, on the night of Sunday, December 4th, noticing that a street lamp burned dimly, attempted to start the carbon. "His kid glove was wet, and, coming in contact with the magnetic part of the lamp, he received a terrible shock. He groaned, and then dropped unconscious upon the ground. When he was picked up a moment later he was dead. The only mark upon him was a small black hole in his thumb." The third case occurred so far back as October 22nd, in New York. George Schneizer, an inspector of lamps of the Harlem Electric Light Company, in leaning forward to watch two men working at a dynamo, struck a lamp with his hat and set it swinging. "Without a thought of danger he caught hold of the round, brass-finished tube which holds the bottom carbon. With a spasmodic shiver he fell to the ground. The men raised him up, and one of them ran across the street for Dr. T. H. Hay. It was not more than five minutes after the shock that Dr. Hay arrived. He found Schneizer just gasping his last breath." In each of these two instances we have men presumably well acquainted with the nature and power of the current traversing the wires and lamps, in the discharge of their duty performing a simple act which results in their instant death. The natural inference is that there must have been radical defects somewhere in both cases, and we are curious to know whether the methods, notoriously less careful than those which obtain on this side, which the American companies adopt in running their wires had aught to do with the sudden extinction of these young men's lives.

THE directors of the West India and Panama Telegraph Company have issued a circular to the shareholders in which they state that they will not proceed with Mr. William Abbott's scheme of reorganisation which was discussed at the last general meeting. The reason for this decision is that, in the form proposed by Mr. Abbott, the scheme, according to counsel's opinion, is contrary to law and cannot be carried into effect. The counsel consulted submitted a scheme of their own devising, but the directors do not seem very anxious to adopt it.

PARIS AND SCOTT'S NEW DYNAMO.

[A COMMUNICATION.]

IN this machine the conductor on the armature is wound in very deep and narrow slots cut in the iron plates forming the core. The result of making these slots very narrow is that the noise and heating of the pole pieces usually produced in machines with toothed armatures are conspicuous by their absence, as the armature presents what is practically a continuous face to the pole pieces, while by making the slots very deep there is plenty of room for a large quantity of conductor to be wound on, and also for the especially good and thick insulation which is used, the makers considering durability and freedom from risk of breakdown to be of the first importance. Other considerations, however, have not been sacrificed; the magnetic resistance is so low that a very intense field in the armature core, 23·6 Kapp units per square inch sectional area, is produced with a very small expenditure of power in the field magnets, so that the electrical efficiency is very high, especially when the comparatively low speed, 850 revolutions per minute, is taken into consideration. The resistance of armature is ·029 ohms. The resistance of magnets is 35 ohms. Loss in armature with 120 ampères 417·6 watts; loss in magnets with 100 volts 286 watts; total electrical loss 703·6 watts, showing an electrical efficiency of 94·46 per cent.



The field magnets are of cast iron, by the use of which the cost of the machine is much reduced. Although this cast iron is of great sectional area, being nearly three times that of the iron in the armature core, yet the total weight of the machine illustrated, having an out-put of 12,000 watts at 850 revolutions, is only 1,268 lbs., and the armature complete only weighs 147 lbs.

Where lightness is important, as in some motors and in ship lighters, by using wrought iron for the field magnets, the weight of the machines with this type of armature is reduced to an unequalled extent, one to exert 8 H.P. continuously at 1,000 revolutions weighing only 240 lbs., and having an electrical efficiency of 93 per cent.

The mechanical construction also of these armatures makes them specially suitable for motors for tramcar and electric railway work, the plates forming the armature core being made with hexagon holes and threaded on a hexagon shaft, so that each one is driven direct, and as the conductor is wound in slots in these plates, the torque which the whole will stand is clearly very great.

WIRING.

By G. L. ADDENBROOKE.

WHEN installing the electric light in a house or public building of any kind, the running and disposition of the conductors to carry the current have hitherto usually come in for but secondary consideration as compared with the engine, dynamo, accumulators (if used), the fittings and lamps.

That this should be so is not unnatural, considering the greater cost and attractiveness of the engine and dynamo, and the interest attaching to their working, and also considering the novelty and variety of the effects produced by the fittings and lamps. As, however, central stations become more plentiful, and prime motors tend more to become concentrated in one place, the only obstacle to the introduction of the light into houses besides bringing the mains to them will be their wiring and fitting. For I do not think when people come to know more about the light than they do generally at present, that, at any rate amongst the better-off classes, there will be any serious objection to pay even a considerably enhanced price per candle-power for the light as compared with what they are at present paying for gas.

Again, from the capitalist's point of view, as central stations are established, it will be very important that they should supply something like their full quota of energy soon after they are ready to start. Otherwise, a large amount of capital will be lying idle. Now the chief obstacle to getting a large number of lights taken up quickly will be found to be the difficulty in inducing people to have their houses wired.

When a householder begins to think of having the light in his house, there are a great many compensating advantages which are likely to make him cheerfully agree to pay £5, £10, or £20 per annum more for the electric light than for the gas; but on the other hand, when already having gas fittings all over the house, he finds that he will have to pay from say £30 to £100 down to have his house wired, that he himself must put up with very great inconvenience, or remove himself and his family for a fortnight or so while the wiring is being done, and further than that, when it is completed he will have to spend a further considerable sum in re-painting and making good decorations so as to make the place look respectable again, then he is likely to come to the conclusion that there are a great many reasons why, although he is fully alive to the advantages of the light, he should not be in too great a hurry to proceed. For instance, besides the natural hesitation to put up with the necessary amount of inconvenience, a man may find it difficult or be unwilling, although his income is enough for his wants, to expend the capital requisite; or he may be an annual tenant or only have a short lease. In these two latter cases he would probably refer to his landlord. Then the landlord, unless he is anxious to improve the value of his property and can spare the capital, is likely to raise objections and make difficulties; probably he will try to throw the onus on the tenant. Landlords are doing this now and will certainly continue to do so, as far as possible, because if a tenant gives up, then the landlord gets back his house plus the electric light fittings, which he can advertise as an attraction. These obstacles have not been met with on a large scale as yet in England, because most of the private people who have gone in for the electric light have either owned their own houses, or been wealthy enough to make the cost of its adoption a secondary consideration. But there is no room to doubt that in the course of the next two or three years these questions will give much food for anxious thought to those engaged in pioneering the electric light industry.

Fortunately, all that has been said above does not apply with equal force to commercial and industrial centres and to shops. There the adoption of the light has proceeded, and is likely to proceed, at a more rapid pace, because commercial men are alive to the value of keeping their offices cool and clean, as well from an economical as from a hygienic point of view, whilst the loss which shopkeepers who store perishable materials suffer from the action of the compounds given off by burning gas is too well known to need enlarging upon.

It must be understood that in setting forth these difficulties and obstacles it is not done with any desire to retard the progress of electric lighting, but on the contrary, to further it. These difficulties—unfortunately only a few of those the electrical engineer will have to meet—are these: they are at present part of the constituted order of things, and must, if success is to be attained and progress made, be encountered and overcome somehow.

Therefore to acknowledge them, to bring them forward and to discuss them, is more likely ultimately to forward the end we have in view than a policy of ignoring or keeping them carefully in the background would do. Especially is this the case, as these very difficulties have already once been met and successfully combated by the gas companies, and the numerous satellites who surround them and make a handsome living out of the various branches into which such a business as the gas industry, in the widest sense of the word, ramifies. The early history of commercial enterprise in gas is very instructive, and the records of its early applications and adoption, of its successes and failures; of its impurities, of its unsteadiness, and the interruptions to which the supply was liable, should form interesting and encouraging reading to those who are now concerned for its more modern rival illuminant. Now those who are responsible for the success of the gas industry have succeeded in making it almost a necessity within the areas of supply, not by altering the relation of landlord and tenant, not by reducing the cost of their product to by any means an unremunerative figure, but by making the thing simple and efficient in adoption and use, and little liable to get seriously out of order, and by arranging all the connections and fittings so that they can quickly and cheaply be got and can be put up and fitted with a minimum of the mess and inconvenience which this class of work necessarily entails.

One great element in the ease and celerity with which gas fitting is performed is the adoption of standard sizes of pipes, and standard threads for the screw work in connection with them and with fittings. Almost everything, therefore, in gas work now is interchangeable. If a globe is broken or a gas burner gets worn out, it can be replaced from the nearest shop with the certainty that it will fit. Unfortunately, this is not as yet by any means the case with electric light fittings, except so far as they correspond to gas fittings or are simply gas fittings altered.

Some firms even go to the length of purposely making the things they manufacture of different sizes from those of other people, in order that other people's work may not fit theirs, and so, as they think, customers always be obliged to come to them for everything. But this is a short sighted policy in the long run.

It may be thought, outsiders seem to be under the impression as a rule, that since the wiring of a house simply consists in running two conductors about from room to room branching off a main, and that as these conductors are only wires, that therefore fitting up a house for the electric light cannot be so expensive as fitting it up for gas, with all its paraphanalia of iron pipes and joints and angles and elbows and so forth. But if anyone will take the trouble to get an estimate for fitting up, say a 10 or 12 roomed house with gas and also an estimate for wiring the same house from a firm doing electric installation work, the fittings to be similar in each case, I think they will be rather astonished at the difference. Besides this, as wiring is only too frequently done now, it is much more obtrusive and unsightly than gas fitting, makes more mess and is more trouble to carry out.

That it should cause more mess and trouble than gas fitting is, however, not altogether the fault of the way it is done, but is due to the fact that owing to the convenience of pendant lights and their being one of the least expensive forms of fitting, people go in for them largely instead of grouping all their lights in a room together in a chandelier as is usually done with gas.

Consequently, to carry out work of this sort, either the conductors must be run about all over the ceiling or a great many of the boards in the room above must be taken up, and long extra lengths of casing must also in addition be run so that the switches may be in a convenient place for turning the light on and off; on the other hand, in the case of gas a simple piece of compo. piping alone would be taken across the joists of the floor above to the centre of the room, from which a chandelier of several lights would be suspended. Only those who have to plan and carry out such work can fully appreciate the large amount of extra care necessary to carry out work neatly when switches for pendant lamps from the ceiling are situated on the walls of the same room as the lamps are in, and the difficulty there is in arranging them so that the lines of casing may not spoil existing cornices and decorations or look unsightly. With gas, the taps being always or nearly so in the fittings themselves, all this switch business is avoided, and all the compilation and network of wires to which it not infrequently leads. Certainly it is often a great convenience, sometimes a necessity, to have the switches at some distance from the lamps and also from the line of the conductors, and this convenience is usually sufficient to warrant the extra cost of so arranging them. But when people wish switches so arranged, it is a thing which should be pointed out to them and be borne in mind in extenuation of the extra trouble and interference with decorations which is entailed and which they frequently object to.

Again, formerly it was considered quite sufficient to staple a couple of lightly insulated conductors close together under cornices, across ceilings and down some dark corner of a room. People were delighted with the celerity, cheapness and small amount of inconvenience with which such work was carried out, and apparently nothing could be simpler and more efficient, but all this has been changed. Such work was put up by unskilled workmen directed by others who were not as wise or careful as they are now. Faults appeared, earths and short circuits occurred, and the public and the fire insurance companies began to get alarmed. The reputation of the light as the safest of illuminants was at stake. A complete change was effected. Staples were tabooed, casing everywhere was deemed necessary, cut-outs were brought forward and the use of asbestos and slate spread in all directions.

The delightful simplicity of those early days passed away and modern installation work, as now carried out under the ægis of the fire insurance companies, is often subject to a variety of onerous and expensive restrictions which would certainly have considerably damped the ardour of the early pioneers had they been subject to them.

That there was a certain amount of ground for this alarm and that there is some reason for these restrictions, no one who is acquainted with the class of work which was done in the early days can doubt, nor can anyone in this matter blame the fire insurance companies. They are only doing to the best of their power what everyone else does, protecting their property. It is rather for electrical engineers to enquire if there was an altogether inherent viciousness in the way in which electrical engineers started doing this kind of work, whether casing, cut-outs for every lamp, double pole cut-outs on mains, slate bases fundamentally necessary for switches, slate boxes for cut-outs, asbestos fibre, asbestos putty, asbestos paint and so forth, are part of the natural order of things, or whether they are simply a phase in the progress of electric lighting. If they are, or are to be, their use should be systematised as soon as possible; if they are not, the sooner they give place to some better and more practical method of carrying out such work the better.

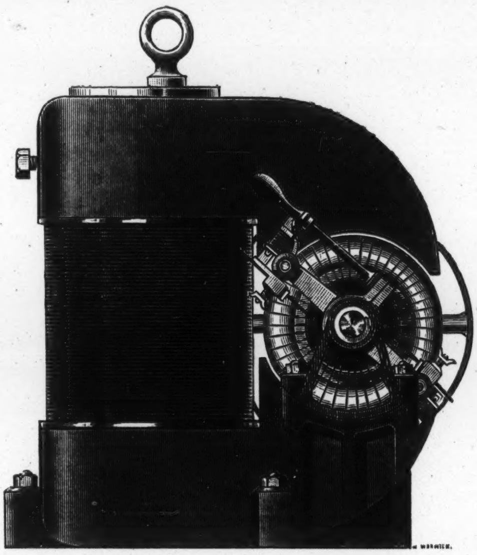
In considering wiring and installation work then, these are three different aspects which are interdependent on each other and from which it must always be regarded. To look at it simply from one or two of these points of view, as is so frequently done now, is not sufficient if entirely satisfactory results are aimed at, and if credit is to be gained by doing such work and progress made. The three different stand points from which wiring must always be considered are, efficiency, cost, and appearance. It is no good having a perfectly efficient system if its cost is prohibitive and its appearance revolting. On the other hand, it is useless having a cheap system if it is not efficient, while, of course, however necessary and important it is, appearance must be subordinate to reasonable efficiency, even if it is not to be so to cost. I have not mentioned simplicity, because practically efficiency and cheapness nearly always go hand in hand with simplicity.

In making any enquiry of this kind, it is particularly important to get rid of all indefinite and general statements, of all rumours of what has happened in certain undefined places at undefined times, only to take as correct and reliable accounts of mishaps of which clear and precise details are forthcoming, into which a competent engineer has enquired, and where there is no reason to doubt that the effect is really due to the cause alleged. For it frequently happens, owing to want of knowledge by workmen and other persons of the laws which govern the flow and actions of electric currents, that effects are set down, not to the causes which have actually produced them, but to some others, and to avoid similar mischances, precautions are afterwards taken which are either beside the mark or could be carried out more effectually in another manner.

KENNEDY'S SINGLE HORSE-SHOE MAGNET DYNAMO.

MR. RANKIN KENNEDY has lately been introducing a new type of dynamo, the construction and merits of which will be gathered from the following report made by Prof. Jamieson upon a 10-unit machine, supplied to Messrs. John Lawson and Son, of Forfar, in whose works it runs continuously from dusk till daylight:—

"I tested this dynamo on Friday, the 4th November, 1887, and had it run continuously for eight hours at full load (with the exception of about half-an-hour during the workmen's meal hour). The dynamo, which is a self-regulating, compound-wound machine, consists of a single horse-shoe magnet, with an armature of the Gramme type. The core of the magnet is made of soft hammered scrap iron, the pole-pieces of hematite cast-iron, and the armature core of soft charcoal iron washers. The whole machine is exceedingly simple, strong, well-proportioned, and well put together. It is just the kind of dynamo for factories, mills, workshops, and steamers, for it may be left in charge of any ordinary mechanic or fireman, with a minimum chance of its getting out of order. All the adjustable parts are readily accessible, and the armature may be removed and replaced in as short a time as, and with less trouble than, almost any form of dynamo that I have seen. There is no perceptible sparking at the brushes. The commutator and the brushes, both from their construction and composition, as well as the freedom with which the latter can be adjusted, are calculated to last for a very long time. None of the parts of the dynamo showed any signs of undue heating, and the ventilation of the armature was all that could be desired. The dynamo gave an 'output' of 10,850 watts or 108·5 ampères, and 100 volts at 620 revolutions per minute, and the electrical efficiency was 89·3 per cent., which is good for a dynamo expressly designed as a cheap, practical, workshop or factory machine, and not as a special test dynamo for experimental purposes. With due attention to the oiling of the bearings, &c., there is no reason why this machine should not work continuously for a week or more on end, without giving the least trouble; and if the future machines made by the same firm are as carefully designed and constructed as the one I had the pleasure of testing, they should give satisfaction to the purchaser. It is a distinct improvement on their former dynamos."

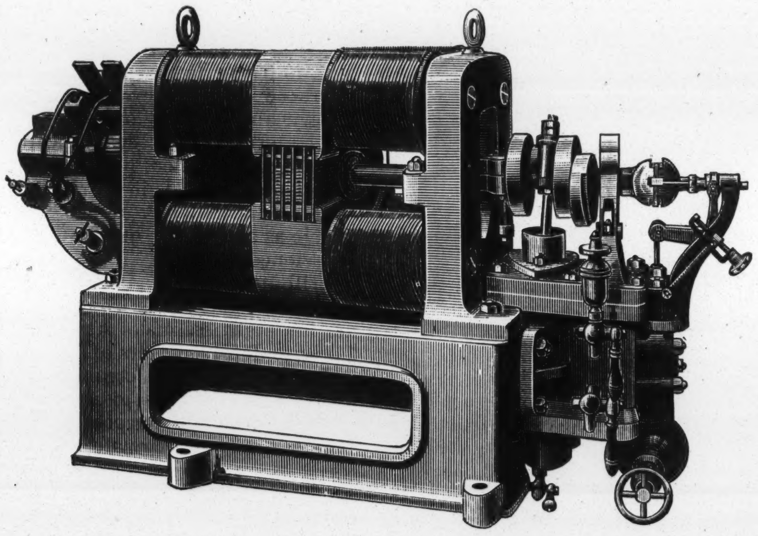


HIGH SPEED TRUNK ENGINE AND VICTORIA DYNAMO.

THIS special and compact form of engine with dynamo combined was designed by Mr. J. S. Raworth, the superintending engineer of the Anglo-American Brush Electric Light Corporation, as an arrangement where space would be so limited as to allow but bare room for a dynamo alone. In the construction of this small high-speed engine many points have been very carefully considered to render it steady, noiseless and durable.

The general type of the engine is shown in the illustration, and it will be noticed that it is of the "trunk" pattern as regards its piston, the trunk being formed of a hardened steel tube ground perfectly true, and fitted at its centre with the piston, which works in a cylinder. Both sides of this trunk are carried through a gland fitted with a metallic packing of a special construction, which makes it self-adjusting, and the lower end of the trunk projects through this gland into a closed chamber, which is drained to remove water. Inside this trunk is the connecting rod pin, which is also of hardened steel, and can be removed. The other end of the connecting rod takes on to the crank pin, and is fitted with brasses having a large wearing surface. The crank is a very excellent piece of work, and is of steel, forming also the spindle of the dynamo. The crank webs, after being slotted and finished, are fitted with iron counter-balances of a shape such that when in place each crank cheek becomes a disc, and wrought iron hoops bored and shrunk on and afterwards turned and polished secure their counter-balances.

The very high speed (900 to 1,000 revolutions) at which this double-acting reciprocating engine works necessitates most accurate balancing of the rotating parts, and perfect cushioning of the reciprocating parts, all of which are made as light as possible to assist this end. The eccentric which actuates the piston valve is also balanced and finally adjusted by experiment. The piston valve itself is very light and most accurately ground into the liner forming its working seat.



The governor is of the well known "Acme" type, fitted direct on to the engine shaft, and actuates an equilibrium valve by a short bell-crank lever. A speeding device is also fitted to adjust the speed of the engine as required. It will thus be seen that the only joint that can wear is the pin in the trunk, and as this is very efficiently lubricated, it is found in practice that very little wear takes place in it. All other joints liable to ordinary wear are easily adjustable at any time, and the inside parts can be easily withdrawn for examination.

The success of such a high-speed engine, it will be seen, depends upon careful detail and high class materials and work more than in any striking novelty in its main parts, and to judge by the way this little engine does its work it appears to be as satisfactory a high-speed motor as any with which we are acquainted, and it no doubt will find a large sphere of usefulness, especially in cases where space is the all-important object. The complete plant, looked on as a generator of electric current, is certainly very compact, as it occupies scarcely any more room than the dynamo with an ordinary pulley on the spindle.

The combined engine and dynano which we illustrate formed part of the exhibit of the Anglo-American Brush Company at the recent Royal Jubilee Exhibition at Manchester, where it was shown at the company's stand in full working order. The engine was a 4 H.P. nominal and the dynamo a Victoria B_2 compound wound, giving an output of 80 ampères and 65 volts. The plant was not utilised to its full power, but was connected on to an A_2 M motor employed in running a turbine, pumping water into a tank, forming altogether a very effective exhibit of re-transmission of energy.

The engine, in all its details, was constructed by the well-known firm of Messrs. Browett, Lindley & Co., of the Sandon Iron Works, Salford, Manchester, who, it may be remembered, constructed the engine with friction gear described in a previous article. We can but add that the combined arrangement of engine and dynamo, and motor and pump, worked remarkably well at the Exhibition, and altogether formed an exhibit which attracted a very large amount of public attention and enquiry.

GLASGOW INTERNATIONAL EXHIBITION.

THE Machinery Annexe at Glasgow next year promises to be one of special interest and importance. As at Manchester there will be a balcony, raised ten feet from the floor, and carried round the whole interior. This will be supplemented by a free passage for the public round the electric lighting machinery, and in this way visitors may have a bird's-eye view from a pleasant height of the whole mechanical and electrical appliances. With the addition of 13,000 feet which has been made, the Mechanical Annexe will cover 130,000 square feet of floor space. Steam power will be generated by nine Lancashire boilers, loaned by Messrs. Penman & Co., Glasgow; Messrs. William Wilson & Co., Glasgow; Messrs. A. and W. Smith & Co., Glasgow; Mr. George Sinclair, of Leith, and Messrs. Daniel Adamson & Co., of Manchester. Of the engines, one will be supplied by Messrs. John Cochrane & Co., Barrhead; one by Messrs. A. and W. Smith & Co., Glasgow; one by Messrs. Bennie & Co., Star Engine Works, Glasgow; Messrs. Mirrlees, Watson & Co., being also among the local contributors; while from England six are to be supplied by Messrs. Robey & Co., Lincoln; four by the Westinghouse Automatic Engine Company, and one by Messrs. Daniel Thomson & Co., Manchester. There will thus be 350 H.P. provided for machinery in motion, and 1,200 H.P. for lighting purposes. Gas engines are likely to come well to the front. Some part of the building will probably be lighted with gas, by way of affording a comparison between this illuminant and electricity.

The lighting of the Exhibition has been made the subject of large contracts. Five of the sections have been entrusted to the Anglo-American Brush Electric Lighting Corporation. No. 1 section, applying to machinery in motion, will be furnished with 93 arc lamps, while No. 2, embracing the courts on the north side of the Exhibition, will be lighted with 104 arc lamps. Section 3, comprising the main avenue, the concert-room or grand hall, the dome, and the transverse avenue, will be provided with 126 arc lamps. The dome is to be treated by the contractors as a special feature of the lighting, and will be fitted with eight arc lamps, suspended from a crown-shaped holder in the centre. Section No. 4, which takes in the courts on the south side of the Exhibition, will be lighted by means of 106 arc lamps. The same company will have the entire lighting of the grounds and walks and promenades. For this purpose 70 arc lamps are to be employed, 45 of which will be raised on iron masts, 15 in number, and each 80 feet in height. The masts will be of wrought iron, fitted with balance weights and Tangye's self-sustaining winches. All unsightly wires are concealed within the column, and by means of the winches and weights the lamps at the top of the masts may be lowered and re-trimmed with the most perfect ease. There are three lamps, held in ornamental brackets, at the head of each mast. In all, the Brush Company furnish 499 arc lamps. Mr. Richard Miller, of Glasgow, sole agent in Scotland for the Thomson-Houston Company of America, is the contractor for lighting the picture galleries, ten in number. This will be effected by four Thomson-Houston arc lamps being fitted up in each gallery. Lest the light should prove too brilliant for the eyes a screen will be drawn under the lamps. The refreshment and dining rooms, extending to about 30 square feet, will be lighted by 750 incandescent lamps, each of 16-candle power, held in ornamental glass shades, and suspended by silken cords.

COMPOUND-WINDING DYNAMOS: BRUSH v. CROMPTON.

By S. ALFRED VARLEY.

(*Concluded from page* 632.)

As already stated in this article I should be very sorry to appear to wish to detract in any way from the credit of those who did what I was not permitted to do, viz., make really self-regulating machines; but, at the same time, the principle on which all compound-wound machines depend, I consider, was covered by the plan devised by me in 1876, much in the same way as the scientific principle which Faraday discovered embraced the mode of action of all magneto machines designed up to the date of the discovery of the dynamo principle, which marked the beginning of a new scientific era, and has produced almost revolutionary industrial as well as scientific consequences.

The dynamo machine and its developments are in a manner so peculiarly a scientific outcome, and its reflective importance on all that relates to science is so great, that whilst on this subject, as I have been taking your readers so much into my confidence, I would ask to be permitted to avail myself of the opportunity to express a few thoughts which have taken hold of me.

Scientific cant seems to me to be now-a-days growing apace, and to be occupying a similar position in respect to the natural sciences that cant at one time did in reference to theology.

One of the last enunciations of what I regard as unmitigated cant is, that there is no such thing as a scientific discovery, that the so-called discoveries simply float about in air of their own free will, or drop down on the ground and are picked up by casual passers by.

A somewhat more invidious form of scientific cant is to appraise the value of scientific developments in accordance with the officially recognised status of the discoverer. If it be made by a scientific leader, or by one of the members of a scientific clique, the trumpet is blown and the beacon fires are lit to proclaim the fact everywhere; but if a discovery be made by an outsider, let its intrinsic value be ever so great, it is at once written down, ignored, explained away, or declared to have been scientifically included and covered by the work of some recognised great man of the past. In the course of this article I have incidentally shown that there has been a sort of conspiracy to deprive me of the scientific credit of the discovery of the dynamo principle, and this conspiracy has been so far successful that current electrical literature, as a whole, ignores my claims.

The form taken of late years by that which I have termed a conspiracy has been the assumption that Faraday's researches, which culminated in the production of a little spark from magnetic force, scientifically embraced the whole of the dynamo principle, and left no further electro-magnetic discoveries to be made.

I would say, look around, and note the consequences which followed Faraday's discovery, and compare them with what followed immediately after the discovery of the dynamo principle.

Faraday was both a conscientious scientific and moral worker; he swept the ground clear which he passed over, but there were stages beyond which he did not pass. I yield to no one in real reverence of Faraday. His face was familiar to me when I was only two years old, for I used Sunday after Sunday, both morning and afternoon, to sit and dream in that little meeting-house which the world would not have known of were it not for the fact of Faraday's connection with it. I was taught and learned to look up to him, and I had that deep regard and feeling towards him which was almost akin to fear, a feeling I never threw off, nor wished to throw off, during the whole time I may be said to have known him. In my opinion he was, in the best sense of the term, a truly scientifically educated man, who not only interpreted, but also thought in the language of science, and this it was, I believe, which gave him what has been lately referred to by Professor Oliver Lodge as an almost intuitive perception of the truths of science.

Still after all, Faraday was only a man, and they are no true friends of his who, under the cover of reverence for his abilities, make use of his name as a stalking horse to deprive others of the credit fairly their due.

I proceed now to comment upon the description of Brush's invention as given in Haddan's amended specification, and I purpose quoting from those parts which are said to relate to compound-winding. To assist those of your readers who may be disposed to consult the specification itself, I would state that when Haddan refers to dynamos as ordinarily constructed, he alludes to series-wound machines, and when describing compound-winding, he says, "I call this device a *teaser*," and your readers will find the word *teaser* is a *teaser* in more than one sense of the term, for it becomes in course of the description everything in turn and nothing long. I notice it chiefly, because it is referred to in several of the plaintiffs' affidavits, and importance seems to be attached to it. No reason, however, is given in the specification for the presence of, nor is there any suggestion in the affidavits as to the functions performed by, the so-called device termed the *teaser*. Not only is there no explanation of this *teaser*, but no explanation which is consistent with the development of the *teaser* as described in Haddan's amended specification can possibly be given.

In sheet 2, fig. 1 of the drawing accompanying the specification, the so-called *teaser* is part of a series-wound machine, in which, of course, there is nothing new.

In Fig. 2 the *teaser* is the shunt circuit of a compound wound dynamo, in which the circuits are arranged in the same way as in my earlier invention of 1876.

In fig. 5 the *teaser* is the shunt circuit of an ordinary shunt wound dynamo, the field magnets of which are wrapped in a precisely similar manner to the original dynamo of Wheatstone as described in his paper to the

Royal Society of 1867, consequently there is no novelty in this arrangement.

In confirmation of what has just been said, I proceed to give condensed extracts from the fourth division of Haddan's amended specification. At p. 10, line 52, Haddan says: "My invention has for its object the maintenance in dynamo-electric machines of the magnetic field," while the machine is running "whether the external circuit is closed or open." This appears to me to be the one and only object Brush had in view in his so-called devices, and he says his invention differs in this respect from other dynamos. After explaining the defects of machines, which he describes as ordinarily constructed (meaning thereby series-wound machines) for certain kinds of work, notably electro-plating, he states at line 8, page 11: "For this purpose a machine arranged to do a large quantity of work at one operation may fail entirely to do a small quantity of work, because of the comparatively high external resistance in the latter case."

After referring to the liability of a reversal of the direction of the magnetism in the field magnets occurring in certain cases as a consequence of the electromotive force developed by the electrodes in the plating bath, he says (page 11, line 19): "It will be obvious if even a *moderately* strong magnetic field be *constantly* maintained within the machine both of the above-described difficulties will be eliminated."

The difficulties here referred to are the failure of the machine to develop electrical energy under conditions described, and the liability of reversal of the magnetism of the magnets in certain cases.

Now, minute and elaborate as is the description which will be found in this part of Haddan's specification, and the pith of which I have quoted, there is no suggestion that Brush expected to obtain from his design an automatic rise or fall of the electrical energy developed, corresponding with the amount of work the machine was called upon to perform.

At page 11, line 22, Haddan says: "Other useful applications of a '*permanent* field' machine will readily suggest themselves. I attain my object by diverting from external work a portion of the current of the machine, and using it either alone or in connection with the rest of the current for working the field magnets. I prefer the latter plan of the two, above mentioned, especially for electroplating."

In the paragraph above quoted, a Wheatstone shunt-wound dynamo and a compound-wound dynamo are referred to as equally novel and original parts of Brush's invention, and there is no distinction whatever pointed out as to the way in which these two different ways of wrapping dynamos differ from one another, with the exception that Haddan says he prefers the compound-wound arrangement for electro-plating, the one special purpose for which it is admittedly not suited.

The paragraph last quoted is the first reference to compound winding which occurs in the amended specification, and it will be noted that there is no mention of self-regulation, nor is there any reference to the way compound winding differs from shunt winding, and neither is there any suggestion of the characteristic feature common to shunt-wound and compound-wound dynamos, viz., that the magnetic field rises and falls as the resistance in the external circuit lessens or increases.

I would call attention to the fact that Brush lays stress on the words "permanent field," and commences the sentence from which I have quoted with the words: "Other useful applications of a 'permanent field' machine," showing that this was the object he had really in view.

On page 11, line 29, in the amended specification, a method of compound winding precisely similar to that given in Varley's specification of 1876 is described.

I have already stated that a great point is made by the plaintiff of the completeness of the description of compound winding which is given in the amended specification, and I will now quote what is said a little lower down in the way of explanation in the same page, commencing at line 35:—"The high resistance of this wire" (he here alludes to the shunt wire) "prevents the passage through it of more than a small proportion of the whole current capable of being evolved by the machine; therefore the available external current is not materially lessened."

This is the *only* explanation which occurs throughout the whole of the amended specification.

Sir William Thomson, when referring to my specification in the affidavit he has made on behalf of the plaintiff, says:—"Varley has not disclosed the idea of a stronger magnetic field when external work is being done, and no external work is being done," and neither has Brush done so, and therefore, as I have already said, they are "hoist with their own petard."

In the sentence immediately following the one last quoted, Haddan says (p. 11, line 38):—"When this device which I have called a *teaser* is used in connection with field magnets also wound with coarse wire, as shown in fig. 1 of the drawing, for the purpose of still further increasing the magnetic field by employing the main current for this purpose in the usual manner, then the *teaser* may be so arranged that the current which passes through it will also circulate in the coarse wire, thus increasing the efficiency of the device. This arrangement, illustrating one of the most prominent applications of my invention, is shown in fig. 1 of the drawings."

Now, this most prominent application of Brush's invention converts the machine into a badly designed series machine, such as no one claiming to have electrical knowledge would think of constructing.

There is a description a little lower down (but which I refrain from quoting, and which commences at line 45) of a compound-wound machine in which Haddan says the series and shunt wires (which he describes as the *teaser* and the helix) may be made of wires of the same gauge, or the shunt wire may be made of a larger gauge than that of the series wire. I make no comment on this beyond stating that it proves my contention that Brush's electrical education at the time he drew up the description of his invention does not seem to have been very advanced.

There is one more modification of Brush's so-called device I proceed to comment upon. At p. 11, line 49, Haddan says:—"Instead of the magnet being surrounded with both *teaser* and ordinary helix, F, the latter may be omitted and the *teaser* increased in gauge and length (thus still maintaining its resistance) until it will maintain sufficient magnetic field. This modified form of the machine, as shown in fig. 5 of the drawings, Haddan says further on (p. 12, line 55, fig. 5 of the drawings) is designed to show the arrangement of the current when the wire, F, is omitted."

This so-called modified form of Brush's device is simply a shunt wound dynamo, and the fact that he calls the magnetising circuit a *teaser* cannot entitle Brush to be regarded as the inventor of shunt wound dynamos.

I have now commented upon, as well as quoted at length, all those parts of Haddan's specification which can be said to relate to compound-winding, and now I propose to briefly sum up the leading points of the case for which I have been pleading.

1. I claim (and I challenge contradiction from any expert) that the diagramatical sketch, fig. 2 (which was made more than a month before the provisional specification was lodged) represents unmistakeably a series-shunt or compound-wound machine.

2. I claim that the part of my specification which I have quoted at length, and which describes the *modus operandi* of my machine, the way the magnets were wrapped, and how the circuits were connected up, in respect to the machine and the external work, is a clear description of a series-shunt or compound-wound dynamo which harmonises with the sketch, fig. 2.

3. I have stated the object I had in view when designing my machine, and the reasons which led me to design the series-shunt arrangement.

4. I have stated what I claim to have done, and what I do not claim to have done.

With respect to the claims asserted by the plaintiffs in the late case, I have to thank Mr. Sellon for the very happy illustration contained in that part of his published letter where he compares the Varley and Brush machines to the rivers of Monmouth and Macedon respectively.

Mr. Sellon does, I am glad to see, admit that there is a resemblance between the earlier machine of Varley and the later one of Brush, for he states: "There are two wires respectively of high and low resistance upon the field magnets of Varley's machine of 1876, and there are *similarly two wires in Brush's machine of* 1878." Now, whilst I am pleased to be able to agree with what Mr. Sellon says, I go a stage further, and I maintain that the elements of automatic self-regulation are quite as much developed in my specification as they are in Haddan's lengthy description of Brush's so-called devices. Sir William Thomson has stated in his affidavit: "Varley has not disclosed the idea of a stronger magnetic field when external work is being done, and when no work is being done." I challenge Sir William Thomson to point out any passage in Haddan's elaborate description of Brush's invention where the idea is disclosed of a stronger magnetic field when work is being done; and if no such passage can be pointed out, what is the intrinsic value of Sir William Thomson's affidavit in the late case? I would go even further, and ask Sir William to point out any passage which indicates that Brush had any idea that the two circuits wrapped on his field magnets would act differentially. I would like to ask Mr. Preece, who has also made an affidavit in the late case, and who has known me for about thirty years, whether differentially-wrapped electrical apparatus was not known to telegraph engineers, and whether he really thinks I did not know the electrical effect of what I had designed; and further, whether he can indicate any passage in Haddan's specification which points to any other conclusion than that Brush's object was simply to obtain a permanent magnetic field.

I maintain that the evidence I have adduced in support of my contention that Brush has no claims whatever to be considered the first to describe a system of compound winding is crushingly complete. The fact that he coined the word *teaser* has a suspicious look about it, and he has certainly turned it to extraordinary account in his specification, for he has mixed up together Varley's series-shunt and Wheatstone's shunt systems, and with the aid of the *teaser* he explains away altogether the permanent field which at the beginning of the fourth division of his specification he states is the chief object of his invention; and further still, with the assistance of his *teaser*, he describes as an original and important part of his invention what is really, as shown in his drawings, as well as in his description, simply a series-wound dynamo.

In conclusion, I hope I may be excused if I say I feel I have had some share in the development of the electrical industry that has grown up during the 50 years I have lived. At all events I have the satisfaction of knowing that when I pass away, as many of my best friends have already done, I shall leave behind me a more permanent record than simply a tombstone. I certainly designed and constructed the first self-exciting dynamo, and I was the means of throwing open the dynamo principle to the trade generally. I have no hesitation in saying history will award the credit of constructing the first series-shunt machine to myself rather than to Brush, and if there be a dispute as to whom the invention is due to, it will probably be whether my late brother, C. F. Varley, or myself is to be credited with it.

I have every reason to regret that the legal rights I once held in the matter of compound winding have been allowed to lapse, but I am not disposed *now*, if I can help it, to allow others to claim the scientific credit I consider my due. I inherit some of the Puritanical traditions of my ancestors, who fought and conquered Charles the First, and I am, therefore, not disposed, without a struggle, to allow the Americans to take precedence and claim royalties for an invention neither originating with nor perfected by them.

It used to be considered characteristic of Englishmen that they did not know when they were beaten, and that they still fought and won after they were supposed to be beaten. I would ask the electrical industry as a whole, are they going to yield because a few of their leaders have done so; are they going to allow British rights to be trailed along and trampled upon; and are they going to surrender at the first summons of the Yankee? I am sorry to have to confess that although all the work I have attempted has proved to be sound, and commercially there has been money in it, I have not hitherto reaped a fair reward and I am consequently a poor man; but if the trade will rally round and support me, I will make it a life and death struggle and take up the matter with the determination to win; and the battle is half won when one is willing to do this.

What is wanting is to get public opinion aroused, and I would suggest as a first step that a moderate subscription should be raised, and that this article should be printed as a pamphlet and forwarded to the members of our scientific and engineering bodies with a general statement inviting a moderate subscription, so that the Anglo-American Brush Corporation may be encountered on somewhat equal terms.

It is in the very nature of things that the electrical industry must greatly develop itself in the course of the next few years, and compound winding will become of relatively much more importance than it is at present.

I feel I have now said all I usefully can, and I would express a hope that this article may bring forth a response from your numerous readers, and that the subject may not be allowed to drop until the claims now being asserted by the Anglo-American Brush Corporation are abandoned.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Concluded from page* 629.)

ALTERNATING CURRENT DYNAMOS.

AN alternating current dynamo cannot be very accurately tested by the writer's method described in connection with direct current machines, because there are losses of power that do not exist in direct current machines. The changes of value of the armature current produces losses by Foucault currents in the pole pieces, and perhaps in the armature hub also. If these losses are known to be small, the writer's method may be used. The machine to be tested and another like it, or giving a similar curve are run at approximately the same speed, and are then coupled together through a resistance which is great enough to prevent danger if the machines do not run together properly. The belt is then thrown off the machine to be tested, so that it runs as a motor. If there is difficulty in getting the two machines to synchronise, a coil with a little iron core, or something with self-induction, may be put in circuit. Iron-wire resistance may do.

The power taken to drive the machine is taken with a wattmeter. From this is subtracted the power spent on the armature resistance, which is got by multiplying the armature resistance by the virtual current. In a direct current motor running loose this loss is so small that it may generally be neglected. This is not necessarily the case with an alternating current machine.

Having thus found the stray power, the efficiency is obtained by dividing the output in watts by the sum of the output, stray power, and loss by armature resistance at full load. The exciting power ought also to be included.

Dr. Hopkinson's method may be applied to alternating current machines. Two machines are coupled rigidly so that one opposes the other, and the field of the motor is weakened. The balance of power is supplied by a small direct current motor. The dynamo behaves very much as if it were working on closed circuit transformers. A wattmeter is used to measure the power transmitted by the dynamo. The stray power is divided between the two machines, as in the case of direct currents.

Captain Cardew's method cannot be applied to three alternating current dynamos; but a direct current motor, whose efficiency is known, may be used to drive an alternating current dynamo. The alternating current dynamo may then be connected up and tested, doing its ordinary work.

It may be desirable to find the curve of electromotive force and current of a machine. These can be taken by an electrometer. A contact is fixed to the axle and touches a stationary contact. The stationary contact can be fixed at positions corresponding to different fractions of a period. This contact arrangement, described by Mouton, was used by Joubert, but he discarded the use of the electrometer because he found it difficult to make it work. He had two instantaneous contacts on the axle; it is difficult to see why one would not have done. By moving the adjustable contact into different positions a series of readings can be taken, from which the actual curve can be plotted. A galvanometer must not be used instead of an electrometer.

The current curve can be taken in shunt to a known non-inductive resistance. The needle may then be charged by a multiplier or set of cells.

The curves from transformers can thus be taken also and compared with the dynamo curves.

Prof. Joubert preferred another arrangement. He coupled up a Poggendorff arrangement as if he was going to measure a direct current; but put the contact-maker in the galvanometer circuit. This is perhaps the most practical arrangement. Of course it can also be applied to taking current curves.

Prof. E. Thomson has brought out a very ingenious instrument. A mirror is oscillated on one axis by a small core in a solenoid connected to one circuit, and on another, at right angles to it, by another core and coil. On looking at a bright spot reflected in the mirror a line or closed curve is seen. In fact, curves like Lissajous' figures are formed. This instrument is, however, of doubtful accuracy. The cores must have some inertia, and their attraction, if made of soft iron, is not proportional to the instantaneous current. If soft iron is used in one and magnetised steel in the other, of course figures corresponding to the octave would be obtained with curves of sines. On such an instrument any two similar current curves of the same phase will give a straight line; and if the phases differ very slightly the curve will be too narrow for its components to be determined. In fact, unless one curve is known it is impossible to find the other.

The writer has designed an instrument for automatically drawing the curves, but as it has not been tried yet its description may be postponed.

The speeds of alternating current machines can be taken by means of a pitch-pipe. An ordinary tuning-fork or pitch-reed will do if the user has an ear sufficiently cultivated to tell the pitch of a note which does not belong to the same scale. If not, a pitchpipe may be graduated to read very exactly. It must be remembered that pitch-pipes and reeds have temperature errors. A reed expands and gets flatter when warmed; a flue pipe or whistle gets sharper when fed with hot air, such as the breath.

MOTORS.

The testing of alternating current motors might well be deferred till there are some to test.

It seems generally to be assumed that the only difficulty with alternating current motors is to start them. It seems probable, however, that there will be very great difficulty in designing a motor which will work with reasonable efficiency and varying load. An alternating is a widely different thing from a direct current motor. Take the case of two similar machines driven by belts and coupled in parallel. Imagine first that they have no self-induction, so that the current at any instant is equal to the algebraical sum of the instantaneous electromotive forces divided by the sum of the armature resistances. Such machines would have no tendency to synchronise. If in phase the opposing electromotive forces would neutralise each other at every instant. If they got gradually out of phase an alternating current would be set up and power would be spent on the armature resistances. The machines would contribute equally to this waste. As the machines differed further, the waste would increase until when they were half a period wrong they would both be short-circuited completely.

But if the machines have self-induction, as soon as one machine is ahead of the other and waste begins, the current curve is retarded, and this makes the leading machine do the larger share of the work. The self-induction may be large enough to make the leading machine do most of the work and supply the trailing machine with more power than it wastes. The trailing machine is then a motor. Thus a dynamo and motor with no self-induction would not synchronise in parallel; and it is questionable whether machines can be so designed as to electromotive force and current curves as to give a reasonable efficiency with a varying load.

A motor can be run on a series circuit, and will then be efficient at full load; at no load the current remaining the same, of course the loss by armature resistance is not reduced. The machine does not run away as a direct current motor does, it goes on at the same speed. If overloaded, it simply stops. Unfortunately, there is little chance of series systems coming into commercial use. The efficiency of a series motor can be taken, as in the case of a dynamo. The motor described in the Hopkinson test just mentioned behaves as if it were in a series circuit at full load. Such a test must not be used to get the efficiency on parallel circuits. A wattmeter will take the power given to a motor, and if at any instant the motor acts as a dynamo, the instrument will deduct the power, so that it reads only the power absorbed. A motor can be put to run a direct or alternating current dynamo of known efficiency.

TRANSFORMERS.

The obvious way to test a transformer is to measure the power supplied by means of a wattmeter, and the power given out, and to divide one by the other. The chief difficulty lies in the high electromotive force of the primary circuit. This may be dealt with by Mr. Kennedy's method of using another transformer whose primary is connected to the high electromotive force and the secondary to the pressure coil of the wattmeter. The transformer used for this must have a closed iron circuit, and the secondary should supply very little current. The method is then accurate enough.

If the same wattmeter is used to measure both the secondary and primary powers, or, at least, if the same pressure coil is used, the self-induction error cancels out. This is important, because a very small error in reading makes a large error in the loss of power. A good closed circuit transformer, with a rapidly alternating current, should give about 98 per cent., so that an error of one per cent. in reading may halve the apparent loss of power.

A good closed circuit transformer has not only a high efficiency, but, on resistance, the curves of electromotive force and current in the primary and secondary are almost exactly the same in form and phase. It may then be safe to multiply the virtual electromotive force and current to get the power. But transformers do not generally work on resistance, but on incandescent lamps, and perhaps on arc lamps. In testing the transformer on either of these the wattmeter is safest. If tested on resistance without a wattmeter, the wire must be arranged to have no self-induction, and, of course, iron must not be used. On resistance a Cardew voltmeter and a current dynamometer might be used, but it is safer to adhere to the wattmeter.

A closed circuit transformer can also be tested with comparative accuracy by simply putting an alternating electromotive force on one circuit. Thus the secondary circuit can be connected to the secondary of another transformer, so that low electromotive forces are dealt with. The power absorbed is measured. It will, of course, be small. This is the stray power. If the output is known, the loss by resistance in the secondary is taken; the loss by resistance in the primary is then calculated, allowing enough additional virtual current to give the stray power when multiplied by the virtual electromotive force. The three losses are added together and make the total loss, from which the efficiency is determined.

In measuring open iron circuit transformers the wattmeter method is the simplest and best on both circuits. These need not be fully discussed, as they are practically obsolete. The product of the virtual E.M.F. and current must never be taken on the primary circuit.

INCANDESCENT LAMPS.

As already mentioned, incandescent lamps do not behave like simple resistance, and they do not behave like resistance and self-induction; in fact, they have a kind of way of behaving of their own. A thin carbon appears to follow the current or power spent, by rapidly heating and cooling. The instant of highest temperature is after that of maximum power. If the resistance remained constant, this rise and fall of temperature would not interfere with the curves of the currents and electromotive forces. If it alters in resistance, as it does if it is not exactly at its points of minimum resistance, the curves are interfered with.

In addition to this, carbon is a bad conductor of heat, so that a carbon is generally hotter in the centre than outside. This alters the current distribution to some extent.

The effect of flickering on a lamp is to make it give a higher candle-power with an alternating current when taking the same electrical power as with a direct current. This is because the efficiency increases more rapidly than the power, so that when very bright the candle-power is much greater than the normal, and when dull it is not much less. As the breaking is most likely determined by the highest temperatures, not by the mean temperature, the lamp to last long must be run duller, till its maximum brightness is only equal to the normal brightness with a direct current. The mean light is then less than before, and the power taken is decreased, though not so much, so that on an alternating current a lamp should really be run to give less light than on a direct current, and at a lower efficiency, though with the same power it would have given more light. In practice, a lamp may be tested on the photometer to give about its normal light, and then run under similar conditions. At first sight it might appear that a Cardew voltmeter would flicker, and would therefore have the same sort of variation as a lamp. But the flickering tends to make a Cardew instrument read lower, not higher, so on this account it is less suitable. The flickering effect is probably very small, however, especially with a thick wire and rapid alternations.

ARC LAMPS.

With direct currents arc lamps are treated as if they had a back electromotive force and a resistance. This is a convenient way of looking at it for direct current work, but it is much more likely that the resistance varies, and that there is no appreciable back E.M.F. If the cross-section of the conducting heated air varies as the current, the resistance varies inversely as the current, and there would be an apparent back electromotive force. If this or something like it takes place, the arc would behave in much the same way on an alternating current. The virtual electromotive force might be kept nearly constant and the virtual current might vary, just as the electromotive force and current vary in direct current work. But if the arc has time to cool and increase in resistance between each alternation, the question becomes much more complicated. Most likely it cools too little to make very much difference. The writer does not know of any experiments on these points. The question might be very easily settled.

THE DEVELOPMENT OF THE MERCURIAL AIR PUMP.[*]

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A.

(Concluded from page 634.)

CLASS IIa.—SHORTENED DOWNWARD-DRIVING PUMPS.

Stearn,[†] in 1877, working in conjunction with Swan at the problem of perfecting the incandescent lamp, devised a shortened Sprengel pump. It is obvious that the column of mercury in the Sprengel fall-tube stands, during the later stages of exhaustion, at about 76 centimetres' height, simply because the difference of pressure between the space inside the tube and outside it is about equal to one atmosphere. By removing a portion of the external pressure, the fall-tube may be shortened to any desired extent. Accordingly Stearn applied an auxiliary pump, not at the top as Sprengel had done, to accelerate the early stages of exhaustion, but at the bottom; the collecting chamber, K, being for this purpose closed, and put into communication with the auxiliary pump. Stearn's pump has undergone various modifications; in a recent form[‡] there are three fall-tubes of only about 10 inches length, completely enclosed in a partially exhausted chamber. In this pump there are also means provided for carrying up the mercury from the collecting vessel back to an upper supply-vessel by closing certain taps and opening others which admit the atmospheric air. By this means an extremely small quantity of mercury is made to do duty again and again; and the exhaustion is rapid, because with such short fall-tubes there is less liability of the air-bubbles to stick in the fall tubes. The action of the pump is made automatic by giving a periodic motion to a three-way cock, which puts a lower receiving chamber alternately in connection with the atmosphere and with the partial vacuum of the auxiliary pump. Stearn has embodied sundry other modifications in patent specifications.[§]

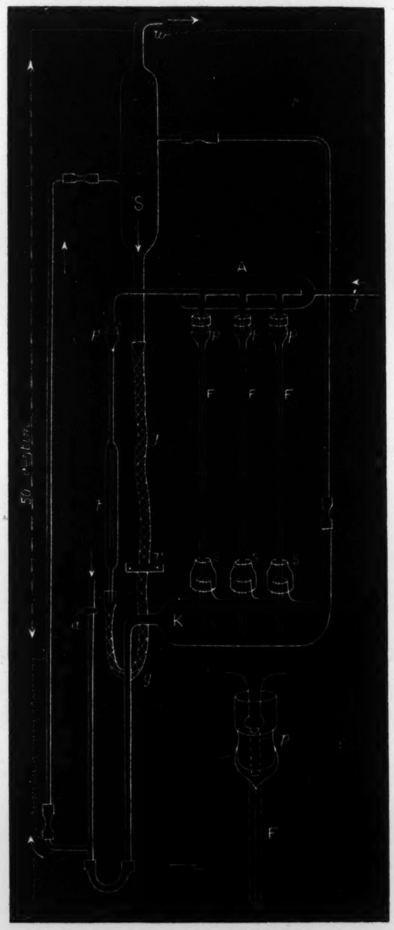


FIG. 26.—NICOL'S PUMP.

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[*] Read before the Society of Arts, Wednesday, November 23rd.

[†] Stearn and Swan. "On a new form of Sprengel's Air-pump." Rep. British Association, 1877, p. 43.

[‡] See Gordon's "Practical Treatise on Electric Lighting," 1884, p. 65, giving an excellent picture.

[§] Stearn. Specification of patent, 5,000, of 1881. See also Dredge's "Electric Illumination," II. p. ccclxiv. Stearn's shortened Sprengel pumps have been now for several years furnished to the public by Messrs. Mawson & Swan, of Newcastle-on-Tyne.

A compact modification of Stearn's pump has been devised by Mr. Swinburne,[*] who also has tried an inverted Sprengel pump.

The most recent shortened Sprengel pump is that of Dr. W. W. J. Nicol, described before the British Association at Manchester in 1887. Its arrangements are depicted in fig. 26. The principle of its automatic action is identical with that of Von Babo, an auxiliary water dropping air-aspirator (not shown in the figure) being employed to draw in air at the aperture, A, regulated by a tap. This air draws up the fallen mercury in drops, through the return tube, Z, on the left, and returns it into the supply chamber, S, at the top, whence it passes downward through a rubber tube, squeezed between the jaws of a regulating pinch-cock, X, and rises through an air-trap, *t*, into the pump-head. The distributor is simply a horizontal glass tube, sealed into the pump-head, and pierced with small holes above the openings of each fall tube. (This form of distributor originated independently with Mr. J. T. Bottomley and with Mr. Proctor.) The fall-tubes, F, F, F, are connected to the pump-head in the following manner. Below the pump-head are sealed, on short pieces of glass, tubing of at least five millimetres bore. These are provided with small flanges, and drawn out conical below, so that they can be pushed very tightly through small India-rubber plugs, *p*, *p*, *p*, which are firmly fixed in mercury cups. These mercury cups, which are strangulated, so as to nip the rubber plugs, are sealed to the fall-tubes. The lower ends of the fall-tubes pass into the collecting vessel, K, through simple packings, *s*, *s*, *s*, of rubber-tube. The arrows show the course of the mercury. The tube, *d*, leads to the drying apparatus, and to the vessel to be exhausted. This pump can, of course, be used for exhausting only, not for collecting the gas for analysis. The entire height of the apparatus is less than one metre. A very small quantity of mercury—only 300 cubic centimetres—is required. The entrance of water-vapour at S or *a* is prevented by the use of tubes containing calcium chloride. These pumps are now manufactured for sale by F. Müller, successor to Dr. Geissler, of Bonn.

CLASS III.—UPWARD AND DOWNWARD DRIVING PUMPS.

The earliest example of a pump which drives the air up one barometric column and down another, is the remarkable pump devised by Professor J. Mile,[†] of Warsaw, in 1828. This pump is described by its inventor as a hydrostatic air-pump without cylinders, taps, lids, or stoppers. The description, as will be seen by fig. 27, is literally true. The mercury is raised in the barometric tube, B, and pump-head, A, by lifting an external cistern, S, of mercury by means of a winch, W. The rising of the mercury first cuts off communication with the vessel to be exhausted by entering the mouth of the exhaust-tube, which is sealed in through the pump-head; and on further rising it expels the enclosed air through a narrow tube, F, sealed in at the top, which bends over to the right and terminates below in a cup of mercury into which its open end dips. This exit-tube and cup constitute a barometric trap, for when the supply cistern is lowered the air cannot return, the mercury rising in the tube, F, to a height depending upon the degree of internal rarefaction. To prevent the mercury from being forced into the vessel that is to be exhausted, the exhaust tube is prolonged overhead to a height exceeding that of a barometric column. The total height of this pump is, therefore, necessarily, about nine feet. It may be looked upon as a sort of Swedenborg pump, the two valves that open inwardly and outwardly into the pump-head being replaced by barometric air-traps. With such a pump, properly used, a fairly high degree of exhaustion ought to be possible. Strange to say, this pump appears to have fallen into utter oblivion, and its useful features have been several times re-invented.[*]

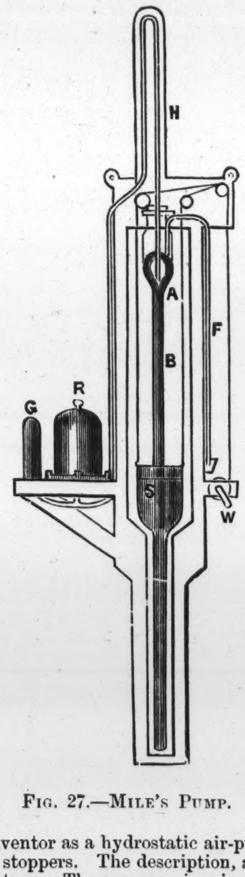

FIG. 27.—MILE'S PUMP.

The use of a second barometric column, down which the air is expelled from the pump-head, is generally attributed to Professor Toepler,[†] of Dresden, whose form of pump is shown in fig. 28. Save in the use of a flexible rubber-tube, and in the manner of bringing the exhaust tube to the lower side of the pump-head, this is identical with Mile's pump. A pump of similar form is sometimes attributed to Mendeleeff; but the writer has been unable to verify the reference. This pump has many of the advantages and disadvantages of the Geissler form of pump. It requires either the tall overhead tube or else an automatic valve. The exit tube, F, is more liable to fracture than any part of the Geissler pump. But, as there are no taps to get out of order, a higher degree of exhaustion can be attained than with any three-way tap arrangement opening into the outer air. There is no need even for any other gauge than the pump itself; for, as Toepler[‡] has shown, the degree of exhaustion can be measured (as in the McLeod gauge) by raising the mercury in the pump-head to a marked point on the narrow tube just above the pump-head, so as to compress the residual air into the top of the narrow exit-tube, and then reading off the volume and the pressure of the same, and making the required calculations. It possesses this obvious advantage, that the last residua of air in the pump-head are swept down the tube, F, by the mercury that falls over the bend—"Sprengelised" over, one

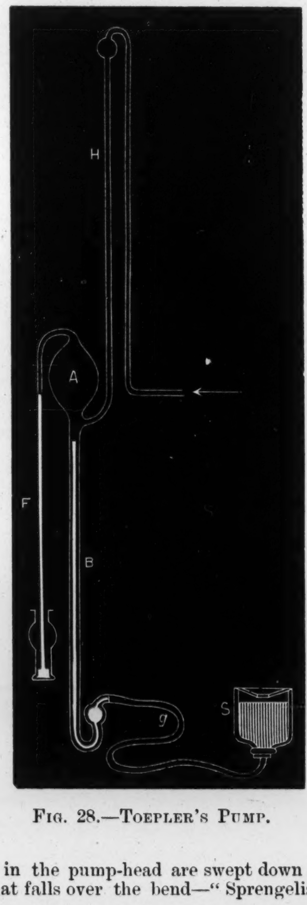

FIG. 28.—TOEPLER'S PUMP.

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[*] Swinburne, *Electrician*, xix., 72, 1887.

[†] Mile. Neue hydrostatische Luftpumpe ohne Kolben, Haehne, Kappen, und Stöpsel. "Dingler's Polytechnisches Journal," xxx., 1, 1828.

[*] See, for example, H. Sutton, in *English Mechanic*, xxxi., 1882, as well as Toepler and Mendeleeff.

[†] Toepler. Ueber eine einfache Barometer-Luftpumpe ohne Hähne, Ventile, und Schädlichen Raum. "Dingler's Polytechnisches Journal," clxiii. p. 426, 1862.

[‡] Toepler. "Sitzungsber. d. Naturwiss. Gesellsch. Isis in Dresden," 1877, p. 135. See also Bessel-Hagen, "Wied. Ann." xii., 434, 1881.

might almost say. In fact, if it were not the case that this pump antedates both Geissler's and Sprengel's, one would be disposed to regard it as a combination of the Geissler and Sprengel pumps.

The Toepler form of pump has received in recent years various modifications. E. Wiedemann[*] altered the overhead tube, H, by joining it at its base with two of Gimingham's air-tight joints, allowing it to be removed to be cleaned. Neesen[†] added the side-tube shown at N in figs. 18 and 33, to prevent the top of the pump-head being broken off by violent uprushes of mercury in the large bulb. Guglielmo[‡] ingeniously connected the closed top of the collecting vessel (into which the exit tube discharged air and mercury) with the closed top of the supply vessel, so that as the latter was raised, and the mercury ran out of it, the air-pressure upon the lower end of the barometric column in F was automatically lessened. Improved forms of overhead tube were suggested by von Helmholtz[§] and by Schuller,[‖] and a very similar device was used by the writer in 1882 to connect a glow lamp to the Lane-Fox pump by merely sealing it to the top of a long barometric tube, which slipped on over the top of the open overhead tube—or of a tube connected with it—and dipped into an external ring of mercury in a cup forming a barometric air-tight trap. Neesen[¶] designed a double-acting pump on this plan, with two pump-heads, and two fall-tubes, the mercury being mechanically driven alternately from one pump to the other by a piston working in a cylinder. The model has not yet been actually constructed.

Other improvements have been made in detail by Couttolene,[**] who drives the air into a partially exhausted space, by Diakonoff,[††] by Bessel-Hagen,[‡‡] and by Karavodine.[§§] The latter interposes between the top of the pump-head and the exit tube, F, a small chamber closed at the bottom by a valve consisting only of mercury standing over a capillary orifice, exactly resembling that previously described by Schuller (fig. 20). This has the result of causing the last portions of residual air to be expelled into a space containing a moderately perfect vacuum. This is a decided improvement. For, as was pointed out with respect to the Sprengel pump, the air carried down the narrow fall tube is necessarily compressed in order to drive it down against atmospheric pressure, and bubbles or films remain adherent to the glass.

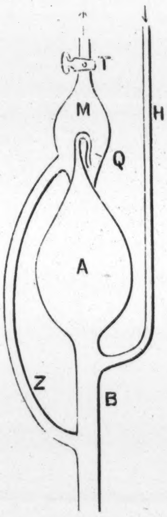

FIG. 29.—SIEMENS'S PUMP (FIRST FORM).

In some modern modifications this is to a very large extent obviated, by the device of so bending the eject-tube or fall-tube, that the air expelled from the pump-head need only descend a very few centimetres down the tube before it enters a chamber that is partially exhausted. In short, if by any device—whether by placing it at the top of a fall-tube or by applying a good mechanical pump—a moderately good exhaustion can be maintained with a chamber such as that marked M, and this chamber is joined to the pump-head by a descending fall-tube, the length of this fall-tube need not exceed the height of a column of mercury representing the difference of pressures between the two chambers. In the diagrams that follow, such a shortened fall-tube is marked Q; it may be regarded as a sort of siphon air-trap. Such an arrangement has been independently devised by several persons. It was patented by Siemens and Halske[*] in Germany in 1884. Fig. 29 shows the device as originally designed. The pump-head terminates in a capillary tube, which turns over into a pool of mercury in the base of the upper chamber, M, into which the residual air is driven with a very slight compression. When a certain amount has thus been collected, it is expelled by further raising the mercury and opening the top tap, T, which is otherwise kept closed. A wider tube, Z, which should be usually closed by a tap, serves to return to the pump shaft the mercury which may have been driven over into M. A later form of this pump, depicted in fig. 30, is used in Siemens and Halske's lamp factory in Berlin.

A similar device was suggested by Sundell,[†] who has further improved the arrangements at the bottom of fall-tube, so as to allow of other gases being admitted to the pump. Some of Neesen's pumps, and that used in the Weston lamp factory in Newark, also have this device; but these belong to the sub-class of shortened pumps, and are described below.

Mr. Swinburne,[‡] who has had extensive experience with pumps of several kinds, has described a form in which this principle is applied. Swinburne's first form, though provided, like Toepler's, with a fall-tube, had also an automatic valve above the pump-head. Fig. 31, taken from Swinburne's paper in the *Electrician*, shows this valve situated above a small cavity, C, separated from the pump-head by a constriction, the object of which is to prevent the glass bottom of the valve being broken by the sudden rise of the mercury. The eject chamber, E, is connected through a tap, L, to a horizontal pipe, marked F in this cut. This pipe which runs along a whole range of pumps in the pump-room of the lamp-factory is mechanically exhausted, and the use of the tap, L, is to start the action of the pumps. After this the action is kept going by a three-way tap (here marked K) which connects the cavity above the mercury in the supply vessel alternately with the atmosphere and a supply of compressed air. In a later form, Swinburne's pump has a siphon mercury-trap between the pump-head and the automatic valve above it. When the exhaustion has been carried far enough, the mercury is lowered and raised some 10 or 20 times, just so far as to drive the residual air through the mercurial syphon, which then will show a small back pressure—perhaps of only one or two centimetres. If the volume of the pump-head is many times as great as that of the cavity beyond the mercury-trap, and if there be a fairly good vacuum beyond the trap, it is obvious that a back pressure of one or two centimetres as the result of twenty strokes may mean a very high degree of exhaustion. Swinburne remarks that the bore of the siphon tube used as a trap must be not larger in the descending part than in the part that ascends to the supplementary chamber.

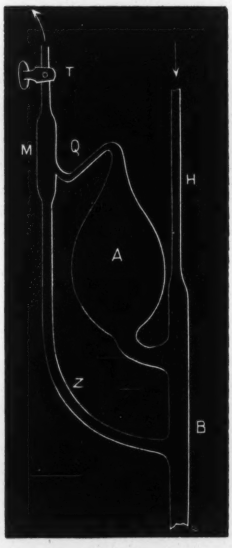

FIG. 30.—SIEMENS'S PUMP (FACTORY FORM).

CLASS IIIA.—SHORTENED UPWARD AND DOWNWARD DRIVING PUMPS.

Swinburne's pump just described might, if worked intermittently with an exhausting instead of a compressing pump, be transferred to the category of shortened pumps.

Probably the more perfect of pumps in this class is that of Prof. as constructed in 1887, is shown in fig. 33. The lower portion is

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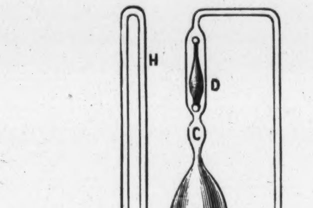
[*] " Wiedemann. " Wied. Ann.," x., 208, 1880.
[†] Neesen. See below.
[‡] Guglielmo. " Wied. Beibl.," v., 16, 1881.
[§] Von Helmholtz. See Bessel-Hagen, " Wied. Ann.," xii., 429, 1881.
[‖] Schuller. " Wied. Ann.," xiii., 533, 1881.
[¶] Neesen. " Wied. Ann.," xi., 522, 1880.
[**] Couttolene. " Comptes Rendus," xci., 920, 1880.
[††] Diakonoff. See Karavodine.
[‡‡] Bessel-Hagen, *loc. cit.*
[§§] Karavodine. " Journal de Physique," S. II., vol. ii., 558, 1883.

[*] Siemens and Halske. D. R. Patent, 28,579, Jan., 1884. For the accompanying sketches of the pumps the writer is indebted to Herr von Hefner Alteneck.
[†] Sundell. " Wied. Beibl.," ix., 193. 1885.
[‡] Swinburne. The *Electrician*, xix., pp. 51, 71, 117, and 158, 1887; a series of papers giving a summary of valuable experience in exhausting glow lamps.

F. Neesen,[*] of Berlin. This indefatigable worker has introduced, from time to time, several improvements. As mentioned above, he introduced the side-tube, N, in 1878, and designed a double-acting Toepler pump in 1880. Independently of Mitscherlich, he introduced the automatic valve above the pump-head. In 1882 he was already employing the recurved siphon trap, Q, between the pump-head and the second chamber, M. His complete pump, constructed on Robinson's plan, air-tight connections being formed at the three necks of the bottle, L, by the use of coned steel collars, that are cemented to the three tubes, and fit to coned adapters, cemented to the three necks. Steel screw caps clamp down the conical collars into their respective seats. The tube, Y, is put into alternate communication with the atmosphere, and with a good mechanical air-pump, so as to raise and lower the mercury alternately in the pump-head, A. There is an automatic valve, U, in the exhaust-tube, which leads up to the drying flask and to the lamp or other vessel that is to be exhausted. This valve, which is shown enlarged in fig. 34, is made somewhat on the plan of Schuller, described above, with a small glass disc about two centimetres in diameter, cut from thin plate-glass, which, as the mercury rises under it, is pressed up against a flat flange, fashioned on the lower end of the upper tube. It works in a manner that leaves nothing to be desired. This pump is further provided with a chamber, M, and a siphon-trap, Q, down which the residual air from the pump-head is expelled into a moderately perfect vacuum.



[†] FIG. 31.—SWINBURNE'S PUMP

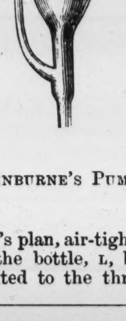


FIG. 32.—SWINBURNE'S PUMP (LATER FORM.)

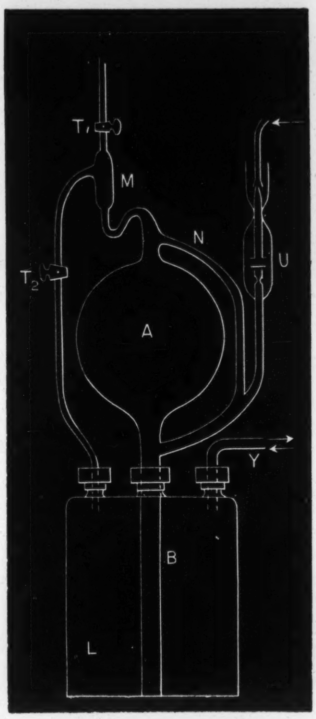


FIG. 33.—NEESEN'S PUMP.

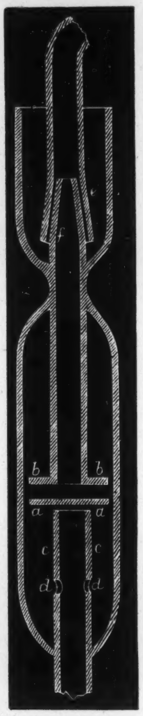


FIG. 34.—FORM OF 1887.

Another very interesting and extraordinary pump belonging to this class is that of P. Clerc, depicted in fig. 35. The apparatus shown is connected by a flexible rubber tube to a mechanical pump capable of giving a moderately perfect vacuum. The apparatus consists of a disc of wood, round the periphery of which is fixed a glass tube, closed in itself, but provided with a U-shaped bend to serve as an air-trap. At one side of this trap rises a short branch tube to which the lamp that is to be exhausted is sealed; at the other a similar branch tube leads to a bulb connected through a tap to the auxiliary pump. Enough mercury is placed in the tube to occupy about a quarter of the circumference and fill the trap. The whole apparatus is mounted obliquely upon another disc of wood, in such a way that it can be rolled round on its periphery by means of a projecting central handle. A preliminary exhaustion having been attained, the tap is closed and the apparatus is rolled around. The mercury in the tube sweeps the air before it into the bulb, and, passing into the trap again, emerges to push a fresh quantity from the lamp in front of it,

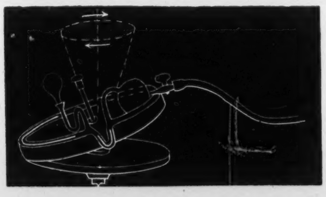


FIG. 35.—CLERC'S PUMP.

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[*] This figure is kindly lent by the editor of the *Electrician*.

[†] Neesen. "Wied. Ann," iii. 608, 1878; *ib.*, xi., 522, 1880; *ib.*, xiii., 384, 1881; "Zeitschr. für Instrumentenkunde," ii., 287, 1882; *ib.*, iii. 245, 1883; also, "Wied. Beibl.," vii., 651, 1883. Figs. 33 and 34 are from sketches kindly furnished by Prof. Neesen.

[*] Clerc. "Dingler's Polytechnisches Journal," cclxii., Part II., 1886; also "Zeitschrift für Instrumentenkunde," vi., 403, 1886; and D. R. P. 36,447, of 1885.

leaving behind every time in the trap a sufficient quantity of mercury to balance the difference of pressure between the bulb and the lamp. The quantity of mercury required for this apparatus cannot exceed a few cubic centimetres at the most.

Fig. 36* represents the pump used in the lamp factory of Mr. Weston, at Newark, New Jersey. The second chamber, M, connected with the pump-head by the syphon-tube, Q, will at once be recognised, as also the automatic valve, U, in the exhaust tube. The mercury in the supply-vessel, S, is raised and lowered by alternately connecting the upper part of the vessel through the three-way tap, Y, with a mechanical exhaust pump, and with the atmosphere. The top tap is only used when the chamber, M, has to be put into communication with the mechanical pump; the other taps are safety taps, not used during the working of the pump. The tap between the lamps and the valve, U, is worse than useless.

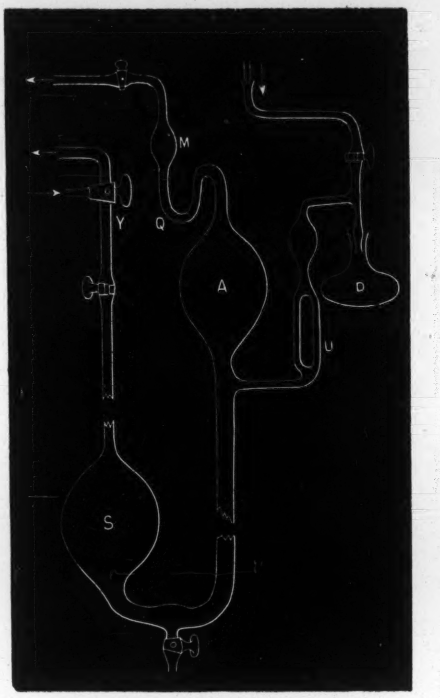

FIG 36.—WESTON'S PUMP.

CLASS IV.—COMBINATION PUMPS.

It has been suggested by Edison † and by Böhm ‡ to combine a Geissler pump with a Sprengel pump in the endeavour to obtain a more perfect result. This method of combination, which consists merely in sealing the exhaust tubes of each pump together and to the lamp, cannot be commended. If the Geissler exhausts more perfectly than the Sprengel, or *vice versa*, then the other pump is useless. A much more hopeful combination has been suggested by Mr. J. T. Bottomley,§ who proposes to utilise a Geissler arrangement to exhaust the chamber into which the foot of the fall-tube of the Sprengel is led, thus putting the two pumps into series.

CLASS V.—INJECTOR PUMPS.

There are a few pumps depending for their action upon the principle of the injector, the degree to which they exhaust depending upon the velocity of efflux of mercury from an orifice, as in the original injector of Hauksbee. The earliest of these were designed by Cavarra ‖ and Plateau.¶ Another form, exhibited in 1876 at South Kensington, was invented by Prof. von Feilitzsch,** in which two cylinders, fitted with pistons, worked by cranks, drove a mercury blast through suitable jets and drew in air, so creating a vacuum. It exhausted down to a pressure of 1 millimetre, or about 1,300 millionths of an atmosphere.

Several other injection pumps of the centrifugal species were described by de Romilly * in 1881, one of them being designated as a *pnéole.* Nothing is known to the writer as to its performance.

CLASS VI.—MECHANICAL MERCURIAL PUMPS.

Only one pump is known to the writer as coming definitely within this category; and this is a pump designed and constructed by Mr. J. Wimshurst, and of which no account has hitherto been published. It consists of an endless chain of little steel buckets, which pass up one barometric column and down another, within steel tubes containing mercury. Below, they enter a mercury bath, where they pass under two square pullies, rising over a higher driving pulley between the two. The buckets as they descend, mouth downwards, carry down air from above the top of the barometric column, and discharge themselves as they come up in the mercury bath. Owing to the fact that it has hitherto been found necessary to employ oil as a lubricant, the power of this highly ingenious apparatus to produce a vacuum is limited.

There are a few pumps concerning which the writer has not been able to obtain information, including those of Diakonoff, Neveux, Pfluger, and Southby, which are known to him by name only.

RESULTS.

The results that have so far been obtained by various pumps may be briefly tabulated as follows: the vacua produced being specified both in millimetres and in millionths of one atmosphere.

If Rood's method of measurement be correct, the results attained by him are very remarkable.

Authority.	Nature of Pump.	Pressure in Millimetres of Mercury.	Pressure in millionths of one atmosphere.
Crookes	Improved Sprengel (maximum result..................	0·000 046	$\frac{1}{17}$
Gimingham ...	Single-fall Sprengel, 1·1 millim. diam.	0·000 51	$\frac{2}{3}$
„ ..	Five-fall Sprengel	0·000 006	$\frac{1}{125}$
Rood............	Plain Sprengel	0·000 152	$\frac{1}{5}$
„ ...	Rood's Sprengel, heated ...	0·000 002	$\frac{1}{388}$
Bessel-Hagen	Old Geissler, after 25 strokes	0·110	145
„	New Geissler (2 taps), after ditto (average)	0·008 5	11
„	New Geissler (2 taps) (maximum result)	0·008 2	$10\frac{1}{2}$
„	Old Toepler, after 5 strokes	0·007 5	10
„	„ after 5 more...	0·006 4	8
„	Modified Toepler (average)	0·000 012	$\frac{1}{63}$
„	„ „ (maximum result)	0·000 008	$\frac{1}{95}$

CONCLUSION.

On comparing the experience of various workers, it seems as if the best class of pump for the production of such vacua as are required for lamps is the third class, as modified so as to drive the air up the pump head and down a simple short barometric trap into an already partially exhausted chamber. No one appears to have yet tried a shortened Sprengel with a crook in the fall-tube. The writer offers it as a suggestion. Further, if the experiments of Rood are worth anything, they indicate that an immense advantage is gained by working with pumps heated up above the boiling point of water. The "adsorption" of gases and vapours against the surfaces of glass and mercury in the working parts of the pump is certainly much less hot than cold. Why should not all pumps be so constructed as to enable this method to be adopted? Since much seems to depend on the purity of the mercury, why should not the mercury be distilled direct into the pump? Whenever cements are used, why should not some plastic inorganic substance, such as chloride of lead or tungstate of lead be employed, instead of resin, pitch, or other organic body, which will give off vapours. Lastly, if the device of exhausting into an already fairly well exhausted chamber so greatly improves the degree of rarefaction attainable, why should we not carry this process one or two stages further, and relay a series of pumps one working into the other? Such a process would resemble those processes of successive operations which have been called "Pattinsonisation;" and it is possible that it might yield results surpassing anything yet attained.

In surveying the literature of the mercurial air-pump one cannot but be struck with the immense number of workers who have contributed to the invention and the number of details that have been independently reinvented by different individuals. The literature of the mercurial pump affords, indeed, a striking proof of the fact that inventions grow rather than are made. The invention is essentially the product of the age in which it appears, a necessary consequence of the inventions and discoveries that have preceded it. The scientific method of investigating historical events has shown us how false, how childish, is the "great man" theory of history, which was taught—and alas! is taught still—to us at school. But if the great man theory of history is fallacious, so is also the great man theory of inventions. There were steam engines before Watt, locomotives before Stephenson, telegraphs before Wheatstone, telephones before Bell, gas engines before Otto. It may be that occasionally an inventor strikes upon a valuable or useful improvement; it is exceedingly rare for an absolutely original invention to be sufficiently perfect to be of immediate use. Of the essential insufficiency of the great man theory of inventions, the literature of the mercurial air-pump affords a most striking proof.

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* For this sketch the writer is indebted to Prof. G. Forbes.

† Edison. "Scribner's Monthly Magazine," Feb. 1880, p. 538; "English Mechanic," xxxii. 117, 1880; see also Urbanitzky, "Das Elektrische Licht," 1883, p. 56.

‡ Böhn. See Merling's "Elektrische Beleuchtung," p. 394, or Urbanitzky, *op. cit.* p. 63.

§ Bottomley. "Rep. Brit. Assoc.," 1886, Birmingham Meeting, p. 519.

‖ Cavarra. "Comptes Rendus." 1843.

¶ Plateau. Hervorbringung eines Vacuums mittelst der Centrifugalkraft des Quecksilbs. "Pogg. Ann." 151. 1843.

** Von Feilitzsch. Theorie und Construction einer hydrodynamischen Luftpumpe. Greifswald, 1876. See also "Mitth. des naturwiss. Ver. v. Neupommern und Rügen," ix., 1877; and Catalogue of Loan Collection of Scientific Apparatus (1876), p. 134.

* F. de Romilly. "Journal de Physique," Ser. 1, vol. x., 303, 1881; Ser. 2, vol. iv., 366, 1885.

The investigation of this literature, which has long occupied the writer, has been a fascinating pursuit, partly because of its unexpected richness, partly on account of the fascination of the subject. Everyone who has worked with mercurial air pumps must acknowledge to a kind of fascination in watching the ebb and flow of the liquid metal, and in speculating on the nature of the actions that go on in the vacuous spaces. It was, perhaps, with some such sense that Hauksbee, after describing one of his physico-mechanical experiments, wrote these words:—"Such a dense and polite Body is Mercury; such a subtle Mover is Air; and such an apt Repository is an Exhausted Receiver."

Discussion.

The Chairman said he had listened with great pleasure to this most interesting paper; before he came into the room he thought that he knew something about the mercurial air-pump, but his only feeling now was how much there was still to be known. His name had been mentioned in connection with high vacua, but he must say that his idea of a vacuum varied very much as the work went on. In his early days, when they worked by mechanical means alone, an exhaustion of a millimetre was looked upon as very good indeed, and a little beyond that would have been thought almost a perfect vacuum. Then Sprengel's pump was introduced, and with this we easily got the barometer gauge and the barometer itself level, and that was then called a perfect vacuum. Then the apparatus was used for the various physical experiments which enabled them to detect the pressure of residual air, and the vacuum was in this way seen to be very imperfect. Then chemical means were employed, such as filling the tube with carbonic acid and absorbing by potash. Then those taps which figured in nearly all the pumps had to be done away with, for no good could be obtained if there was a tap or a lubricant. When all this was effected, as in the best form of Sprengel, the vacuum suddenly improved, until it would not conduct electricity. Finally, by McLeod's gauge, with the modification of Gimingham, we could actually measure the vacuum, and then we found we had what was scarcely worth calling a vacuum at all. The best he had ever succeeded in getting was the one-hundredth of a millionth of an atmosphere, which was equivalent to one-tenth of an inch at the top of a barometer tube 200 miles in height. That sounded like a very good vacuum, but when a small tube containing a centimetre of air was exhausted to that extent, there would still be left in it 10 billion molecules. The nearer they got to perfection, the farther off it seemed, and the more hopeless it appeared to think of getting a perfect vacuum by any available means.

Mr. J. Swinburne, referring to the relative advantages of the long and short Sprengel pump, said he had tried a good many of each, and he must say he preferred the long one. The short one looked better on the table, but the advantage was more apparent than real. If any air got taken down a certain part of the shaft, say 6 inches, it was safe enough, and never got back again if the pump worked properly. The chief disadvantage to the short shaft arrangement, was the difficulty of preserving a mechanical vacuum. Those he had to do with in commercial work he had found very troublesome, and he would never use one in lamp manufacturing if he could help it. He preferred to use a long shaft with air pressure to lift the mercury. He should like to know the Chairman's opinion as to the measuring of these vacua, because the figures given seemed to him purely fancy figures, and reminded him of the candle-power of arc lamps. In the first place, the McLeod gauge must have some mercurial vapour in it; he did not know whether the tension of that had been accurately determined, but, according to Regnault, it was about 50 millionths, and if that was so, it was absurd to talk of getting a vacuum anything below that. The next point which was put was the way in which air, gas, or vapour seemed to flatten out against the glass. You might have what seemed to be a good vacuum; when mercury was let into it slowly, it would show a bubble, but if admitted quickly would go right up with a smack, and there would be nothing visible at all. In opening bulbs or lamps under mercury, considerable care must be taken, and then many would fill completely with mercury, which would mean a perfect vacuum. Of course, if the McLeod gauge was worked like that, it showed there was something deceptive. Again, taking several lamps off the same pump, and testing them, it would be found that different results were obtained both with coils and opening them under mercury. A good Geissler pump was its own gauge. Referring to the drawings of his own pump, which had been described by Prof. Thompson, in which there was a bend, Q, and a little chamber, M, with a valve at the top, he said he had never used it commercially, for it was a far better pump than was needed for that purpose. The object of the bend and the chamber was to meet the point which had been urged; all the pumps shown exhausted into a moderately good vacuum, but that little pump exhausted into a vacuum which was as perfect as any of the other pumps could produce. The vacuum in M was as perfect as it was in A in the other pumps. By exhausting into the little chamber, M, and taking, say, 20 strokes, you could get a vacuum to as many millionths as you felt inclined, but about the accuracy of all such measurements he was sceptical. In the first place, if it could be depended on, the vacuum would increase in geometrical progression, but if you worked to any point you liked, and then left it for two hours and came back, you found quite a different state of things. Mercury vapour gave very different effects when tested with a coil and in other ways. In such a pump as that, it seemed impervious to a spark until it was put in connection with a lamp, and then immediately there was a green phosphorescence under ordinary circumstances. That seemed to show that mercury vapour was a non-conductor, unless some air was mixed with it. He believed that had been discovered at the beginning of the century. He had always followed the practice of distilling the mercury, because when it was once put into one of these pumps it lasted until the pump was broken. Silicate of soda was a good cement, and got perfectly hard. He did not know whether he had mentioned, in the paper he sent to the *Electrician*, that he had tried the same system of elevation as Nicol, except that the three shafts were all joined together in one piece, instead of being joined with India-rubber. But there was a great difficulty in regulating the flow of air, and if by any means it went wrong, the mercury got into the phosphoric acid tubes, and into the lamps. As to the relative merits of the Sprengel and the Geissler, the general idea was that the Geissler did to rough out with, and the Sprengel to finish the exhaustion. He should prefer to use a Sprengel for roughing out, if it would do it, but he always finished with a Geissler. He used the form shown on the diagram, with the siphon bend and second chamber, and in making comparative tests he had always found that the Sprengel stopped working long before the Geissler.

Prof. W. Ramsay said Prof. Thompson deserved the greatest credit for having brought together sound valuable information. With regard to the McLeod gauge, he thought it possible that some of the air really flattened itself against the glass, or, perhaps more correctly, adhered to it, and formed a sort of condensed gaseous film, so that the ultimate amount measured was not the actual amount in the bulb, but only a small fraction of it. It was quite certain that if the temperature were not kept quite even, a correct measurement could not be made. As a practical point in connection with the cleaning of Sprengel pumps, he would recommend the use of glacial acetic acid, which had such a high vapour pressure that it removed itself. Even with the cleanest mercury one got films of oxide formed, and in the Sprengel pump, where the little drops fell, there was always a film of oxide formed. This was readily dissolved with glacial acetic acid, and another advantage connected with its use was that you need not pour it in, you only need attach a vessel containing it to the apparatus, and the vapour would pass over in sufficient quantity to clean the pump.

Mr. R. P. Sellon said there was one point worth notice, which Mr. Swinburne had already touched upon. When you tested the vacuum of a glow lamp by opening a globe under mercury, you sometimes got a very different result from that which you obtained by testing with a Ruhmkorff coil. That was probably due to the fact that the residual air in the globe, broken under mercury, became condensed, and flattened out against the sides of the globe, and thus escaped detection.

Mr. C. V. Boys said he had not done much with mercurial air pumps, but he remembered when Prof. Rood's form was described making one, and testing it with a McLeod gauge. The special points about it were the heating, the crook, and another point which had not been referred to. As to the crook, there was no doubt that a small quantity of air always stuck round the upper end of the column, that was swung over and caught on the lower side of the crook, and he was satisfied that was a good thing. The effect of heating was most remarkable; he kept the apparatus so hot that he could not touch it, and the first visible effect was that the reflection of the mercury in the tube was much brighter, as if it were more intimately in contact with the glass; in fact, the film of air which undoubtedly sometimes existed was to a great extent squeezed out. The other point was this: that the mercury, according to Prof. Rood's instructions, was not put into the top of the pump, as in all others of the Sprengel type, but was allowed to fall in a small stream through a bulb. When it began to work, the bulb was entirely filled with mercury, and the equator of the bulb was beneath the level of the fall-pipe. As soon as the vacuum began to get pretty good in the fall-tube, the mercury in the tube fell, and there was above it a very good and very hot vacuum. Then the mercury, in an exceedingly fine stream, was delivered through that vacuum hot, and gave up there any entangled air and moisture, and fell into the space below in as good a condition as mercury could be. He tried one of these pumps with a McLeod gauge. In a hot pump, when there was no crook, the hammering noise was enormously greater. Of course, this hammering, owing to the vibration which ensued, allowed a minute quantity of the air which was carried down to escape back again. The introduction of the crook stopped the hammering, and, of course, prevented the escape of air. There was no reason why people should not always use distilled mercury. Clark's apparatus was very simple, and you could, at a push, distil as much as 14 lbs. per day with it, which would probably be sufficient for all commercial purposes. He was sorry Prof. Thompson had not said more about the centrifugal form of pump. About 10 years ago he had an idea that it would work very well, and set about making one, 6 inches high and 6 inches in diameter. What corresponded to the fall-tube in a Sprengel pump were radial arms with the ends curved in, and he was in hopes it would work well, but the result was it did not work at all; he did not get more than about a foot of vacuum altogether. He believed the reason was the shape of the radial tubes, and that if, instead of being straight they had been curved like a turbine, the pump would have worked. However, he did not care to undertake making such a thing in glass, and let the matter drop. He had heard considerable doubts expressed whether the figures of the McLeod gauge represented what was supposed. As to the flattening of a minute trace of residual gas between the mercury and the glass, although that will happen when the mercury was let into a bulb, he fancied that under the circumstances in which it was used in the gauge, the mercury slowly rising, with a large expanse above it, would allow the residual gases to rise until they were caught in the small tube, and then there would be such a small surface of mercury that there would not be much room for error on this account.

Mr. W. M. MORDEY said he felt much indebted to Prof. Thompson for pointing out so clearly where to go for information on this matter. With regard to paraffin wax as a cement, he might say that about nine years ago he made a barometer of rather thick glass, and happened to break the end in sealing it. He simply dipped it in paraffin wax and filled it up in the usual way, and it had worked quite well ever since. He quite agreed with Prof. Thompson's theory as to invention. He believed an inventor was one who, in 99 cases out of the 100 gave audible voice to whispers that were in the air.

Mr. BOYS said he had found amixture of pitch and gutta-percha make an excellent cement; but of course no organic compound would compare with sealed glass.

Prof. THOMPSON, in reply, said Prof. Rood gave a receipt for cement, consisting of 96 parts of Burgundy pitch and four of gutta-percha. There was a very convenient form of mercury distiller now available, much simpler than Clarke's, and one which any amateur could easily make with two pieces of barometer tube; it was described by Nebel, and he would put a rough sketch of it on the board. Sulphuric acid would remove itself as well as glacial acetic acid, though not perhaps so quickly. He had hoped that Prof. Ramsay could have given from his own researches some more precise figures than Régnault as to the vapour pressure of mercury. Régnault gave it at about 20 millionths of an atmosphere at the freezing point.

Prof. RAMSEY said that should be divided by about 200.

Prof. THOMPSON said Bessel-Hagen gave it as 26 millionths at 20° C., and H. Hertz at about 17 millionths. In the figures Bessel-Hagen gave, he distinctly stated that he subtracted from the observed result in the gauge (which was simply the top of a Toepler pump) 26 millionths as the supposed pressure of mercury vapour, and assumed that the remainder represented the pressure of the residual air. That answered the point which Mr. Swinburne had raised. Bessel-Hagen made exactly the same remark as Mr. Swinburne, as to the Geissler pump going on extracting the air longer than the Sprengel. There was no doubt that air pressing upon mercury or glass did adhere to the surface; that was one reason why, exhausting from a chamber in which there already had been made a moderately good vacuum, you got a much better result. The mercury was then returned into the pump without having had any great air-pressure put upon it. For that reason he differed from Mr. Swinburne as to the use of air-pressure to lift the mercury. No doubt he was correct in saying it was difficult to get workmen to make a satisfactory mechanical apparatus; plumbers did not know very well how to make tubes air tight, and to make them vacuum tight was still more difficult, but he did not see why a mechanical difference of this kind should be allowed to stand in the way if the pump would work better when the mercury was never exposed in any part of its journey to the ordinary pressure of the atmosphere, but only worked from a moderately good vacuum to a more perfect one. For this reason he had emphasised the peculiarities of the later forms of pump, which exhausted only between one stage of vacuum and another.

The CHAIRMAN, in proposing a vote of thanks to Prof. Thompson, said McLeod's gauge was no doubt imperfect, but it had been found that by taking certain precautions the indications could be relied on, within a certain margin, very well indeed. For instance, the mercury must be squirted into the pump through as good a vacuum as the pump had up to that point reached, and the surrounding vacuum would take all the air from the surface of the mercury, so that it entered the pump freed from air films. The pump and everything connected with it must be heated to as high a point as was safe for some time before trying to get a measure of these high vacua. It was true the measurement was only that of the residual air, not of mercury vapour, but that was easily managed. The mercury vapour diffused very slowly through long spiral tubes, and it could easily be kept out by a little device which he published some time ago. By putting between the bulb to be exhausted and the pump a long tube containing in the middle of it a little iodine, and on each side of it powdered sulphur, the mercury would not pass the iodine because it was converted into a solid iodide of mercury. The iodine would not pass the sulphur because it was converted into iodide of sulphur. But the sulphur would, perhaps, get into the pump, and so they put powdered silver outside the sulphur to keep the sulphur out. In that way you might keep the whole mercury vapour out, and the gauge would only show the residual air which was in it. It struck him some time ago what a blessing it would be to physicists if gallium were cheaper; it was a metal which was liquid at 86° Fahr., and would remain liquid at temperatures much below that; it gave off no vapour, and did not oxidise in the air, so that it was an almost perfect metal for a pump of this kind. There was an alloy of gallium and aluminium, which was much lighter, but unfortunately it decomposed in water. There was one point in connection with this paper which specially commended itself to the Society, and that was that without these mercurial pumps we should have had no incandescent electric lighting. Another point was that it had given a new employment to women. Formerly glass-blowing was entirely confined to men, and when he wanted pumps made commercially at first he had to pay £10 or £15 a-piece for them. In connection with some others he started a factory in which the whole glass-blowing was done by girls. It was easy work, just suited for their delicate fingers, and they became as skilful as any of the men. The wages were good, the hours short, and a great deal of work could be done at home. A Sprengel pump, for which he used to give £10 or £15, the girls thought they were handsomely paid for making at 10s. He believed most lamp manufacturers now employed girls to do the glass blowing, for the pumps were always breaking, and had to be repaired on the spot.

The vote of thanks was carried unanimously, and the meeting adjourned.

REVIEWS.

Progress in Electrotechnics. Quarterly reports on recent results in the whole region of applied electricity, including electric reporting and signalling.* By Dr. KARL STRECKER, with the co-operation of Dr. M. KILIANI and Dr. E. PIRIANI. First volume, 1887. First and second parts. Berlin: Julius Springer.

This new publication proves two things—the vast extent and importance of the modern development of applied electricity, and secondly, the diligence and thoroughness of the author and his coadjutors. The work is divided into five main sections: Electro-mechanics, electro-chemistry, electric reporting and signalling, measurements and scientific researches, and lastly, terrestrial currents and atmospheric electricity. Each of these sections is then subdivided into a number of chapters. Thus the section on electro-mechanics includes: 1. Dynamos, electromotors and regulators; 2. Distribution and conduction; 3. Electric lighting; 4. Electric transfer of power; and 5. Promiscuous applications.

No fewer than 73 journals and transactions are regularly searched by the editors in order to obtain every new discovery or invention which has been made public. At the head of each chapter we find a very full table of contents, and short marginal notes summarise each paragraph, thus rendering it exceedingly easy to seek up any particular subject required. If any reader wishes for a fuller account of any subject than he can obtain in this book, he will find in the table of contents to each chapter a reference to the original documents. We may thus say that this work furnishes a complete index of all that has been published on practical electricity during the last quarter. It would be almost an insult to the understanding of our readers were we to enlarge on the manifest value of such a publication.

Management of Accumulators and Private Electric Light Installations. A Practical Handbook. By Sir DAVID SALOMONS, Bart., M.A. Third edition, revised and enlarged. London: Whittaker & Co., Paternoster Square, E.C.

To say that this book is the best of its kind would be a poor compliment, as it is practically the only work on accumulators that has been written. The writer has produced a book which is exceedingly valuable, and which is compiled with much attention to detail, a point which is of very great importance to those who have to deal with a subject which is by no means an easy one to tackle successfully. A large number of devices appear to have been tried in order to render the installation at Broomhill (the author's residence) as automatic in its working as possible, and eventually an entire success appears to have been achieved. According to the author, the installation, which replaced a private gas works, resulted in a decided economy. The author regards primary batteries as of no value for electric lighting purposes, though he to some extent makes an exception in favour of the Upward battery; at the same time he considers the production of a good primary battery within the bounds of possibility.

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* *Fortschritte der Electrotechnik.* Viertel jäkrliche Berichte über die neueren Erscheinungen auf dem Gesammtgebiete der angewandten elektricäts lehre mit einschluss des elektrischen Nachrichten—und signal—wesens.

Although we can speak in very high terms of the value of Sir David Salomon's work, we regret that greater care should not have been taken in the compilation. As a matter of fact the book is written in the most slip-shod style, the Queen's English being most terribly mutilated; moreover, the explanations given are in many cases most difficult to decipher correctly, proper names are wrongly spelt, and altogether the editing is careless in the extreme.

Theory and Practice of Electro-Deposition. By. Dr. G. GORE, F.R.S. New edition. London: Charles and Co., Salisbury Court, Fleet Street.

This book was originally written in 1856, and has now been altered and added to (not by the author, but by a "competent authority") with the object of bringing it up to date. The additions made, however, do not add much to the value of the book. The portion relating to dynamo-electric machines, for instance, practically consists of nothing but a few illustrations of the outside appearance of the same with very brief descriptions. The general alterations appear to be rather meagre, and the book still bears the impress of antiquity.

*Calendar for Electrotechnicists.** By F. UPPENBORN. Editor of the *Centralblatt für Elektrotechnik*, and director of the electric experimental station at Munich. Munich and Leipsic: Oldenbourg.

This pocket-book, which now enters upon its fifth year, contains in addition to the usual features of an almanac a variety of mathematical tables, an account of the weights and measures in different countries, and the respective conversions of the metrical and the English systems. Next follow physical tables, mechanical, acoustic, optical, thermic, magnetic, and electric. The bulk of the book is devoted to electrotechnical information in a concise form, clearly expressed and well arranged. Then follows matter having exclusive reference to German conditions, such as post office and telegraph arrangements, fees for technical and engineering work, &c.

An appendix to the almanac, in a separate cover, contains a number of tables, mathematical, mechanical, and electro-technical; the German laws as to steam boilers, the insurance of workmen in case of sickness and accidents, and the patent system.

LEGAL.

Pearson v. Maxim-Weston Electric Company.—In this case, referred to in the REVIEW for October 28th last, Sheriff Erskine Murray has issued an interlocutor. The action was heard in the Glasgow Sheriff Court and was for damages for wrongful dismissal and loss of salary. The sheriff found that the Court had no jurisdiction and dismissed the action, with costs against the pursuer, the defenders' costs being, however, reduced to one-third.

Detroit City Lighting.—The Brush Company has been awarded the contract for lighting this city for three years at the cost of $117,940 per annum.

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* *Kalender für Elektrotechniker.*

NOTES.

Electric Light Litigation in America.—The Brush Company of Cleveland seeks to enjoin the proprietors of a large clothing firm in Indianapolis from using its present system of lighting and for damages for past use. The particular method of lighting which has been employed for four years or more is that of the Fort Wayne Jenney Company, and it is alleged that the apparatus infringes the Brush patents. The suit is looked upon as being of considerable importance.

Central Station in Philadelphia.—The Edison Electric Light Company is about to construct a station in Philadelphia in which 18 engines of a combined 3,600 horse-power, and 36 dynamos will be placed.

An Unlooked-for Danger.—At Wichita, Kan., a scoundrel entered the works of the Thomson-Houston Company and ruined a dynamo as well as seriously injuring two others.

Electric Lighting in Austria.—The central station in Salzburg has only been started a few weeks, but the demand for light is rapidly increasing, and the supply of current is already five times as large as it was at starting. Neuhaus, a town in Bohemia, has also received an installation of arc lamps, overhead conductors being employed. Next year there will be a Trades Exhibition in the Rotunda, says *Industries*' correspondent at Vienna, and as it is intended to keep the Exhibition open in the evening, a liberal use of electric lighting will be made. The interior of the buildings will be lit by various local firms, whilst the grounds and approaches from the Prater will be lit by the Berlin Allgemeine Electricitäts Gesellschaft. The Vienna firms have approached the Minister of Commerce with a request to take over the installation which they are going to put up, as a permanent feature of the building. This proposal he has promised to consider, provided the cost of the installations be moderate.

Electric Lighting in Berlin.—The electric light installation in what is known as the German Theatre, says *Industries*, has now been completed down to the smallest rooms. The lamps employed were made by the new company manufacturing the Seel glow lamp. The following is a list of the lamps installed:—

Five flies, each three rows of 40 lamps, in three colours—red, green, and white	600
Two front wings, each 12 lights	24
Flies over the back of the stage	45
Foot lights	42
Auditorium	106
Foyer	200
Cloak and store rooms	150
Stairs and corridors	150
Vestibule, bar, and box office	150
Offices	18
Total	1,485

On each side of the stage there are five plugs for the attachment of incandescent light cables, and two for arc lights. The latter have separate resistances, whilst the glow lights are regulated by a stage rheostat in groups. The Seel lamps, so far, have stood very well; they can be worked at a high temperature without the risk of breaking, and do not appear to blacken the glass bulbs so much as other forms of incandescent lamps. The manager of the theatre considers the working expenses with the electric light smaller than with gas lights; but in his calculation no allowance has been made for interest on the cost of plant.

Electric Lighting in Mines.—The electric light has been installed at the Ffrwd Colliery, Wrexham, the main roads and surface being lighted throughout. The installation has been carried out by Mr. Charles Lever.

The Electric Light in Iron Works.—The electric light is now, according to *Industries*, widely adopted in the iron works of the Ardennes and the Meurthe-et-Moselle. A blast furnace owner, after a year's experience with arc lamps at his works, says that it is conducive to economy in working in a degree far beyond his expectation.

Electric Light in Paper Mills.—The Hope Paper Mill Cefn-y-Bedd, North Wales, has been lighted throughout by electricity. The dynamo, which has a capacity of 5,000 watts, is driven by water power. The installation has been carried out by Mr. Charles Lever.

The Electric Light in Railway Trains. — The example set by the Boston and Albany Railroad in lighting trains by electricity is now being followed by some Canadian railways. The first train in the Dominion lighted by Julien storage batteries and incandescent lamps is that running between Montreal and Ottawa. On this train a Pullman drawing room car, one first class, and one second class car are fitted with incandescent lamps, the total number being 51. The battery is carried in the first class car, and the current is suppled to the Pullman in front and to the second class car behind by flexible connections, the contact plugs being protected by India-rubber covers which automatically close when the car is uncoupled, and so prevent moisture or dirt getting to the contacts. The Canadian Railway Board has appropriated the sum of £5,000 for fitting up some of the main line trains with batteries and incandescent lamps. The charging stations will be established at Halifax, Moncton, St. John, Point Levi, and Montreal.

The American System in Australia.—We mentioned in our last issue that an American arc light plant is to be erected at Sydney, New South Wales. We are now informed that the apparatus is on the "American" (Wood's) system, and consists of an 800 arc light plant, the largest, it is believed, ever supplied.

The Sawyer-Man System.—The Sawyer-Man Electric Company has already installed more than 300,000 of its well-known incandescent lamps in over 400 isolated and central plants. Single orders are now booked for as many as 100,000, 75,000, and one order is for 1,000 a day. The new works will have a capacity of 10,000 lamps a day.

The Pittsburgh Central Station. — Consider for a moment, says *Modern Light and Heat*, the distribution of light over an area of three square miles from one central point, all controlled by one attendant in the dynamo room. Such is the Westinghouse system as now in practical operation at Pittsburgh with its 14,000 lights.

Bradford and the Electric Light.—At a meeting of the Electric Lighting Sub-Committee of the Bradford Corporation held last week, the committee passed a motion in favour of calling in as consulting adviser in connection with the electric lighting scheme the most eminent authority on the subject whose services could be procured. The action of the sub-committee, we understand, is not the result of any want of confidence in Mr. Shoolbred, its present electrical engineer, who is busy on the specifications of the scheme, but is rather the outcome of a desire that in the carrying out of the undertaking the Corporation may be fortified by an authority of acknowledged eminence from outside.

The Extension of the Telephone.—The growth of the telephone system in Europe shows great variation in the several countries during the three years from the end of 1883 to the close of 1886. The increase in the number of telephone wires was greatest in Switzerland, where it was 1,700 per cent. (from 2 in 1883 to 36 in 1886); Germany, 333 per cent. (from 21 to 91); Austria, 267 per cent. (from 3 to 11); Russia, 233 per cent. (from 6 to 20); and Sweden, 200 per cent. (from 5 to 15). Belgium and Holland follow a long way behind, with an increase of only 50 per cent. (from 10 to 15). In Italy the number of telephone lines increased but 23 per cent. (from 13 to 16); in Great Britain, 19 per cent. (from 75 to 89); and in France, 11 per cent. (from 18 to 20). Germany had at the close of 1886 the largest number of telephone lines, 91; and Austria the smallest, 11. The increase in subscribers has been in proportion to the growth in the number of lines. Switzerland here also heads the list, subscribers having increased by 486 per cent. (from 835 in 1883 to 4,900 in 1886). In Germany the increase was 308 per cent. (from 3,613 to 14,733); Russia, 291 per cent. (from 1,451 to 5,280); Sweden, 267 per cent. (from 1,553 to 5,705); Austria, 248 per cent. (from 870 to 3,032); Belgium and Holland, 151 per cent. (from 2,331 to 5,858); and Great Britain, 107 per cent. (from 7,287 to 15,114). France and Italy are at the bottom of the list, the increase in the number of subscribers in the former country having been only 62 per cent. (from 4,437 to 7,175), and in the latter 52 per cent. (from 5,507 to 8,346). Great Britain still had the largest number of telephone users, 15,114; Austria the smallest, 3,032.

Some Advantages of the Telephone.—"Dogberry" writes in the *City Press*:—The telephone has been found very useful in large business houses, but it is not used by the general public to anything like the extent that was anticipated. The charge for connection is, no doubt, too high for the average private house, yet it is sometimes used there with undoubted advantage. One lady says:—"Instead of tradesmen calling for orders and wasting their time and that of our servants, we now order everything by telephone. There are 12 butchers, 17 fishmongers, 10 bakers, and 8 fruiterers to choose from; so that a large market is open to us, and we can compare prices and buy where we please. Moreover, we can telephone to friends, and so often save an afternoon call. Not long ago my husband, who is a very busy man, was laid up. He had the telephone placed by his bedside, and through it he was able to speak to his clerks, have letters and telegrams read to him, dictate answers, and converse with his clients. Then, being unable to get good stables near the house, we took some at a distance, and had them connected up by telephone—a gain in convenience and a saving of money. About six months ago we had a case of fever in the house, one of the servants being taken ill. We at once telephoned to the fever hospital; an ambulance came and took the girl there within an hour of the doctor's decision, and the removal was effected so promptly that she suffered no ill effects whatever." Some day, no doubt, the price will be reduced, and these advantages extended to a much wider circle.

American Bell Telephone Company.—The monthly statement of the Bell Telephone Company for October shows net earnings of $15,083, being an increase of $4,175 over the corresponding month of last year. For seven months of the financial year, from April 1st to October 31st, the net earnings were $95,604, being an increase over corresponding period in 1886 of $9,604. The list of subscribers connected is steadily increasing.

Electrical Welding and Stage Representations.—The new method of welding by electricity is likely, says *Modern Light and Heat*, to reduce the risks of fire on theatre stages by superseding the picturesque village forge, with its roaring bellows, flying sparks, and dangerous flames, all of which have to do duty at times in romantic plays. A beautiful stage effect was produced the other evening in New York in Wagner's opera "Siegfried," where Siegfried was able to wield his broken sword, "Hot hung" anew, after having it welded by electricity.

West India and Panama Telegraph Company.—From an official communication of the Dutch Government to the Second Chamber of the States General it would appear that the shareholders of the West India and Panama Telegraph Company have congratulated themselves too soon upon the presumed collapse of all competitive schemes. The Dutch Minister of the Colonies says that the prospects of connecting Paramaribo, the capital of Dutch Guiana, by cable with Europe have considerably improved lately. The Pedro Segundo American Telegraph and Cable Company, of New York, who are in possession of a Brazilian Government concession giving them the exclusive right of landing cables on the Brazilian coasts to connect with the systems of the United States, have offered to lay their cables from Vizen, in Brazil, to Paramaribo and thence to Curaçoa, one of the Dutch Antilles. The Pedro Segundo Company ask for exclusive concessions, both in Surinam and at Curaçoa. They also want an annual subsidy of £2,000 during 20 years from the Colonial Government in Dutch Guiana. There is no doubt whatever, says the *Financial News*, that this grant will be made, because the States General have already approved of a similar request, made some little time ago. The Minister of the Colonies adds that the Compagnie Télégraphique des Antilles is already connecting Curoçoa by cable with Hayti and Cuba. His Excellency hopes that by the autumn of next year both Curaçoa and Paramaribo will be in possession of a double telegraphic communication with Europe, viz., *viâ* Brazil and *viâ* the United States.

Snow and the Wires.—Snow has fallen heavily in many parts of Britain and the Continent. In the north and north-western provinces of Spain railway and telegraphic communication has been interrupted; but we have heard of no similar occurrence in this country.

An Excellent Example.—The Brush Company, of Cleveland, O., remarks *Modern Light and Heat*, distributed among its employês last Thanksgiving three tons of turkeys. An excellent example for other corporations to follow.

Personal.—The University of Pennsylvania has appointed Mr. Carl Hering to the entire charge of its electrical engineering department. Mr. Hering has won an enviable reputation by means of his voluminous and clearly written articles and papers upon electrotechnical subjects, and in his new sphere he will doubtless find ample scope for his undoubted abilities.

Mr. C. E. Wetton, who has been for some years with Messrs. Paterson & Cooper, will, from January 1st next, represent the Telegraph Manufacturing Company, Limited, of Helsby, near Warrington.

Mr. Ronald Scott, under whose directions H.M.S. *Devastation*, *Mersey*, *Severn*, *Dalhousie*, *Lawrence* and *Hero*, have been fitted with the electric light, has resigned his appointment as ship-lighting engineer to Messrs. Goolden and Trotter.

Electric Lighting in the Navy.—The contract for fitting H.M.S. *Britannia* and *Hindostan* at Dartmouth with the electric light, has been placed by the Admiralty in the hands of Mr. Ronald A. Scott, of Hammersmith.

Sudden Death.—Edward Miles, aged 40, a telegraph instrument maker, residing at Stoke Newington, suddenly fell down in a public house in Kingsland and expired. Death was due to syncope.

The Three Card Trick.—A young man, giving the name of Thomas Withall, and said to be an electrical engineer, was on Saturday charged at the Westminster Police Court with being concerned with others not in custody in obtaining money by means of "the three card trick." It was alleged on the prisoner's behalf that he was accidentally in the company of the other men, and evidence was given of his good character. He was remanded in the hope that he would disclose the names of his alleged confederates.

Large Dynamos.—Mr. J. Potter, of the Cleveland Brush Electric Company, states that his company has built quite a number of dynamos of 60,000 watts, one for the Cowles Electric Smelting and Aluminium Company's works at Stoke-on-Trent, England, just previous to the building of its "Colossus," and two for the Denver Tramway Car Company.

Walker's Portable Miner's Electric Lamp.—This lamp is at present made in two forms. In one, which is round, are two cells of a bichromate-carbon-zinc battery, in the other, an oval one, there are three. The cells are made in a particular form, the carbon itself being the containing vessel. On one side is a strong lens faced by a parabolic reflector, the two being held by a strong brass cylinder attached to the outer case, which is also of brass or copper. The cells contain the usual porous cells and zincs, and are closed by an India-rubber pad, above which the connections are made in a simple and efficient manner. A second pad of India-rubber is placed above this and is retained in its place by the cover, which is held by screws, or a lock, as desired. A stout handle surmounts the whole. The smaller lamp, made of a cylindrical form, weighs 5 lbs., and gives a light sufficient to read ordinary newspaper print at 6 feet from the lamp for 10 hours. The cost of renewing the chemicals used, the incandescent lamp, and incidental repairs, is stated to be not more than ¾d. per day for the small lamp, and 1d. per day for the large one.

The Van Rysselberghe System.—By the advice of M. le Baron Sadoine, during his journey in China, Mr. C. Poulsen, the director of telegraphs at Tien-Tsin, entered into negotiation with the manufacturers of the Van Rysselberghe apparatus with a view to making experimental installations of that system of simultaneous telegraphy and telephony. In consequence of these trials, which took place in the presence of all the mandarins of the Administration of Imperial Telegraphs, the latter have adopted the system for China, and have already under consideration the adaptation of the line from Shanghai to Tien-Tsin.

Lecture on Dynamos.—At a recent meeting of the University College Engineering Society, Prof. Alex. B. W. Kennedy in the chair, Mr. J. Thoraton read a paper on "Dynamos." After touching briefly on the history of the dynamo, Mr. Thoraton described the essential working parts, giving at the same time the theoretical explanation of each. The author described some of the dynamos in the market with direct current and alternating, concluding with an account of the ordinary method of testing dynamos, and also of a static test for the determination of the magnet coil windings.

Volk's Electric "Dog Cart."—An object of much attention in Brighton just now is an electric dog cart constructed for ordinary roads. The vehicle, which has a front guiding wheel, was made by Pack, coach builder, Brighton. The motor is Immisch's ⅓ H.P. type, the current being supplied by 16 small E.P.S. accumulators, their normal discharge lasting six hours. The cells are placed under the seats. The motor is placed on hangers under the body, and is connected by a Reinold's chain to a countershaft, from which another chain leads to one of the wheels, which has a series of blocks attached about one foot apart, looking neater and weighing far less than any pulley of similar diameter (4 feet). The motor is barely large enough (being only 40 lbs. in weight) for the work it has to do. But valuable data have been obtained as to the power, &c., required to propel a vehicle on ordinary roads. On asphalte the tractive force is less than on a grooved rail, and a speed of nine miles an hour can be attained, whereas on a soft macadam road only four miles an hour is possible. The vehicle with two persons will ascend a grade of 1 in 30. Taken altogether as a first experiment the results may be considered both interesting and satisfactory.

Memorial Engine for the Glasgow Technical College.—A Thomas Russell memorial steam engine was recently presented to the Glasgow and West of Scotland Technical College by Mrs. Russell in memory of her late husband. The engine has been specially designed by Prof. Jamieson as an educational machine, to enable engineering students to make accurate tests not only of the weight of steam and of condensing water required under different circumstances, but also to drive the college dynamos for charging storage cells and working electric arc or incandescent lamps. The engine has been made by Messrs. Hall, Russell & Co., engineers and shipbuilders, Aberdeen. The material and workmanship throughout are first class.

Dynamo with Internal Poles.—Some time ago Messrs. Siemens and Halske brought out a new type of dynamo with internal field magnets. A similar machine was also brought out by Messrs. Ganz & Co., of Buda-Pesth; but priority for the invention has been claimed by two other firms, viz., Messrs. C. and E. Fein, and the Helios Company of Cologne, both of whom lodged protests at the Patent Office when Messrs. Siemens and Halske applied for a patent. From a recent decision of the Patent Office it appears, according to *Industries'* Berlin correspondent, that the protesting parties have been successful, and the following reasons are given for the refusal to grant the patent: "There have been prior publications, notably Patent No. 13,802, figs. 12 and 13, covering the principle of internal magnets placed radially, and the manner of supporting the external armature laterally has also been anticipated in Patent No. 13,158, fig. 2. Although these designs have previously been chiefly used for alternate current machines, it cannot be contended, with the present general knowledge of dynamo electricity, that the application of the design to continuous current machines is a patentable novelty. Moreover, such application has already been forestalled in Patent No. 19,265, figs. 15 to 18." This decision will show how very strict the Patent Office is in dealing with inventions for which patents would be granted in England as a matter of course.

Gas Explosions.—On Monday a gas explosion at the Salvation Army Barracks, Nottingham, blew out all the windows, caused William Hainton to badly fracture both legs, and injured five other persons. On Tuesday a charwoman was badly bruised in Temple Gardens, and a great deal of damage was done by an explosion of gas.

On Wednesday an alarming explosion of gas took place in a public street at Newcastle, the force being such that about two yards of the thoroughfare were blown up, hurling stones in all directions, and lifting up the carriage way for about 10 yards.

Phœnix Fire Office Rules.—The eleventh edition of the Phœnix Fire Office rules, compiled by Mr. Musgrave Heaphy, C.E., contains several important paragraphs relating to transformers. It is recommended that neither the induction coils nor any portion of the primary circuit in connection with them be placed inside any building, but in a fireproof structure apart. When, however, this cannot be done other precautions, which are fully set forth in the rules, must be taken. The question of leakage between primary and secondary coils is discussed and suggestions given for proper protection, but the recommendations for these apparatus are not obligatory at present, except in such particular instances as may be deemed necessary by the inspector from the fire office.

Burning of the Grand Theatre.—Another great theatre fire occurred early yesterday morning, the Grand Theatre at Islington being burned to the ground. Happily the outburst occurred an hour or so after the pantomime audience had left the building. We do not yet know whether either gas or the electric light, both of which were employed in the illumination of the theatre, had any part in causing the fire.

Electricity in the Royal Navy.—Last week there was a brilliant display of electric lighting in connection with the annual amateur theatricals given by the engineer students belonging to H.M.S. *Marlborough*, at Portsmouth. The Admiral Superintendent, while insisting on the use of electricity on the ground of safety, left it to the students to carry out the work unaided by the electrical department of the dockyard, with the result that Messrs. Bryant, Davies and Page, who undertook the whole responsibility, succeeded beyond the most roseate expectations. Not only were the approaches to the ship, the gangways, and the theatre brilliantly illuminated, but incandescent lamps were exhibited in every part of the old vessel with admirable effect, the visitors being delighted.

Hotel Lighting.—The Langham Hotel is to be lighted throughout with electric lamps. The directors of the hotel wisely decided that the lowest tender would not necessarily secure the contract, yet the competition for this work between several well-known firms has been very keen. We believe, for reasons which need not be stated here, that the electrical supply station must, for a year at least, be apart from the hotel, and the lighting will therefore most likely be on the transformer system.

A New Mode of Electric Welding.—It has long been known that the most refractory metals are fusible in the electric arc, and of late the fact has been applied to the reduction and welding of metals. In the welding process of Professor Elihu Thomson, as our readers are aware, the joint to be welded is traversed by an alternating current of electricity strong enough to fuse the metals together. But in the new process of Dr. Bernardo, of St. Petersburg, according to the *Times*, a continuous current from a charged accumulator is employed. The metals to be welded are connected to the negative pole of the accumulator, and a carbon pencil, such as is used in the electric arc lamp, is connected to the positive pole of the accumulator. The consequence is that when the carbon pencil is brought into contact with the joint, and then withdrawn, an arc is started between them, and the metals of the joint are fused in its intense heat until they run together. Carbon blocks are in certain cases used to retain the molten metal in its place, and a little sand is also employed as a flux. By these means boiler-plates can be mended *in situ*, blow-holes in castings filled up, and iron rods jointed together. To weld two pieces of $\frac{3}{8}$-in. boiler-plate, 40 cells of the accumulator joined "in series" and three "in parallel" are taken to supply the current; and a 1-in. carbon pencil in a portable holder is used to strike and maintain the arc. The power of the latter is regulated by the number of cells employed. The accumulator of Dr. Bernardo has plates made of strip lead, he having found that cells with paste in the plates do not stand the heavy discharges which he requires

Massachusetts Institute of Technology.—The twenty-third annual catalogue of officers and students of this institute is a most instructive proof of the excellent educational work proceeding in the city which is recognised as the intellectual centre of the United States—Boston to wit. The catalogue, with a statement of the courses of instruction and a list of the alumni, which is included with it, forms a volume of 164 pages. The students at present in attendance number 818. We learn from the book that the library of the physics department contains the standard works upon various branches of physics, and is especially full in those relating to electricity, all new works of value on that subject being added as they appear. As a foundation for subsequent work, thorough instruction is given in the theory of electricity. An extended course of lectures is devoted to the consideration of the various technical applications of electricity to land and submarine telegraphy, the telephone, electric lighting, and the electrical transmission of power. Besides the teaching given by the regular staff of the institute, special instruction is given by gentlemen who are professionally engaged in various departments of electrical engineering.

NEW COMPANIES REGISTERED.

Clamond (Continental) Incandescent Gas Light Company, Limited.—Capital, £200,000 in £1 shares. Objects: To carry on the business of a gas electric lighting and power company, and particularly to acquire certain patent rights in connection with the Clamond incandescent burner. Signatories (with one share each), W. Griffiths, 30, Woodsome Road, N.W.; E. T. Read, 80, Lombard Street; J. Pearce, jun., East Dulwich; J. A. Petter, Hampton; E. P. Rogers, 37, Walbrook; F. H. Grove, 15A, South Audley Street; T. A. Meates, 2, Tanfield Court, Temple. The signatories are to appoint the first directors; qualification, £200 in shares; remuneration, £300 per annum to the chairman, and £200 per annum to each director. Registered 22nd inst. by Foss and Ledsam, 3, Abchurch Lane. Registered office, 76, Coleman Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Jensen's Electric Bell and Signal Company, Limited.—An agreement of the 13th inst. entered into with the Patents Investment Company, Limited, of Nottingham, provides for the purchase by this company of the patent rights of Jensen's patent electric bell and signal system for £15,000 in cash and £15,000 in fully paid shares.

Schanschieff Electric Battery Syndicate, Limited.—An agreement of the 30th ult., filed on the 8th inst., provides for the purchase by the syndicate from Mr. Alex. Schanschieff certain letters patent relating to batteries, &c., for £12,500 and a further sum of £5,000 upon a resale by the company of the said patents, of which £7,500 is payable by the allotment of 30 fully paid shares of £250 each. Mr. David Marks agrees to transfer to the company his rights and interest, under certain agreements, in consideration of which the company will allot to him 30 fully paid shares.

Railway and Domestic Electric Lighting Company, Limited.—The annual return of this company, made up to the 18th October, was filed on the 19th inst. The nominal capital is £6,000 in £10 shares, the whole of which are taken up. Upon 240 ordinary shares the sum of £5 has been called, and 360 shares (vendor's) are considered fully paid. The calls paid amount to £1,200. Registered office, 6, St. Helens.

Midland Electric Light and Power Company, Limited.—The annual return of this company, made up to the 23rd inst., was filed 24th inst. The nominal capital is £50,000 in £10 shares. 157 shares have been taken up, and the full amount has been called thereon. The calls paid amount to £70, and 150 shares are considered as paid up.

Armstrong's Electric Light and Power Company, Limited.—At a meeting of the subscribers to the memorandum and articles of this company, held at 9, Bridge Street, Westminster, on the 14th inst., it was resolved to adopt and carry into effect the agreement dated 1st November, between James Tarbottom Armstrong, H. F. Ihlee, R. J. Sankey, and J. S. Blease of one part, and Robert Bedford (for the company) of the other part, with the following modification:—That clause 10 of the said agreement be rescinded; that neither of the parties to the agreement be at liberty to give notice to rescind such agreement under clause 10, and that the directors be at liberty to proceed to allotment notwithstanding that 3,000 shares have not been subscribed, and 10s. per share paid thereon.

CITY NOTES.

Telephone Company of Austria, Limited.—Coupons No. 6 of the 5 per cent. debentures of this company, due January 1st, will be paid, less income tax, by Messrs. Martin & Co., 68, Lombard Street, E.C.

West Coast of America Telegraph Company, Limited.—The directors have declared a dividend of 6s. per share for the half-year ending December 31st, 1887, payable on January 7th next.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 23rd were £4,006, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

13111. "Improvements in electric lamps." W. WARD. Dated October 14. 11d. Consists of a lamp containing only one fixed wheel, which acts as a brake wheel (by means of a brake rod and spring) upon the carbon feed, and so simplifies the lamp. For striking the arc a small pivotted lever (above the coils) is employed), on which is a pulley for the cord from the carbon feed rod to pass under; a bracket and regulating screw is fixed to regulate the movement of the lever; when the current pulls down the lever in contact with the coil, it draws the carbon apart and thus establishes the arc. The claims are 3 in number.

13971. "An improved self-regulating electric portable battery and lamp." H. R. FISHER. Dated October 30. 8d. Claims:—1. The arrangement generally of an automatic device by which the electrolyte of a primary battery may be brought into contact with the electrodes or elements and method of connecting and holding same, substantially as set forth. 2. The combination of an electro-magnet and spring with a pawl and rack, as an automatic regulator in connection with the electrolyte and the elements in a primary electric battery, substantially as set forth. 3. In the construction of an automatic regulating primary battery, the use of a chambered pulley containing a spring and acting as a counter-balance to the descending or ascending cells or elements in the manner herein described in connection with a balanced lever, pawl, and rack, substantially as set forth. 4. In the construction of an electric battery the special form of clip for electrically connecting and holding the elements, substantially as set forth.

13974. "Improvements in electric telephony." J. G. LORRAIN. Dated October 30. 8d. Relates to improvements in patent specification No. 15,147, of 1885, and consists in placing in the low tension circuit a primary battery or other suitable source or reservoir of electrical energy. This battery may be connected up in the said low tension circuit in any convenient known manner. There is 1 claim.

16456. "Improvements in electro-phonetic telegraph sounders." H. A. HOUSE and H. A. HOUSE, jun. Dated December 15. 8d. Consists of an electro-phonetic telegraph sounder, whereby electric currents received by the instrument act upon a sounding head to produce audible sounds, and whereby the movements of said head produced by sound are the means of transmitting like movements to another head, and producing audible sounds therefrom. The claims are 10 in number.

13987. "An improved collector or brush for dynamo or magneto-electric machines or motors." J. G. STATTER and S. L. BRUNTON. Dated October 30. 6d. The inventors construct the brush of wire gauze of between 25 and 90 meshes to the inch. The wire gauze is cut into strips of the desired width and length, and the said strips are laid one upon another to any required thickness. The strips are held together to form the brush by any one of the following means, videlicet, by soldering them together at one end, by clamping them between two copper or brass plates, and then soldering these plates and the wire gauze together at one end, by forming a sheathing of wire gauze to hold tightly the strips of wire gauze, and soldering the whole together at one end, or by a sheath or case of metal either held by or replacing the usual brush holders of dynamo-electric machines. In this case the top of the sheath or case is preferably held down by a spring or springs to hold the wire gauze forming the brush tightly, and a feed is arranged for the brush thus formed. The claims are 2 in number.

14033. "An improvement in electrolysis." C. D. ABEL. (Communicated from abroad by the firm of Siemens & Halske, of Berlin.) Dated November 1. 8d. Claims:—1. The method of obtaining copper or zinc directly from their sulphur compounds by a continuous electrolytical process, wherein firstly, the liquid surrounding the anodes is separated from that surrounding the cathodes by an iron metallic diaphragm, secondly, the anodes consist of electrolytically insoluble conducting bodies, such as carbon or platinum, thirdly, a mixture of copper or zinc solution is used as electrolyte, and, fourthly, the flow of this electrolyte through the apparatus is so conducted that it first passes through the cathode cells, then through the anode cells, and lastly through the roasted or melted sulphur ore, after which the regenerated liquid is led back to the cathode cells. 2. In the process referred to in the preceding claim, causing two different liquids which are to be subjected to electrolytic action to flow continuously through the positive and negative cells, which are separated from each other by non-metallic diaphragms, the one liquid being made to flow consecutively through all the negative cells, and the other consecutively through all the positive cells, whereby the one will be subject to a reducing action and the other to an oxidising action.

14106. "A method and apparatus for conducting electricity to moving vehicles." C. Pollak and G. Binswanger. Dated November 2. 8d. Claims:—1. The described method of conducting electricity from a continuous conductor to a moving vehicle by providing a discontinuous conductor in insulated lengths on which successively bear collectors carried by the vehicle, whilst the attractive influence of a magnet or solenoid, also carried by the vehicle, causes successive magnetic contacts to put the continuous conductor in communication with the parts of the discontinuous conductor then in contact with the collectors. 2. Apparatus for conducting electricity to a moving vehicle arranged and operating substantially as described with reference to the drawings.

14489. "Improvements in apparatus for lighting railway carriages and tramcars by electricity." C. Smith. Dated November 9. 11d. Relates to apparatus in which a dynamo is driven from one of the axles of a carriage and the current passed into a secondary battery or accumulator from which the lamps are worked, and consists chiefly in an arrangement whereby the guard or attendant may be able readily to disconnect the gear by which the dynamo is driven from the axle so as to put the dynamo out of action whenever the accumulator is fully charged, or whenever the train is ascending a steep gradient. The claims are 3 in number.

14563. "Improvements in secondary batteries." J. S. Sellon. Dated November 10. 8d. Claims:—1. In secondary batteries or electrical accumulators elements in the form of shallow trays or other suitable vessels which form, hold or support the respective elements of the battery and contain the electrolyte, and so constructed that the under part of the one tray or the like forming or holding the one element dips into the electrolyte contained in the next vessel beneath which forms or holds the opposite element, the whole being arranged or combined, substantially as indicated. 2. The arrangement or combination of parts constituting the secondary battery or electrical accumulator, substantially as described and illustrated in the drawings.

14673. "Improvements in apparatus for the preparation of bleaching solutions by electrolysis." E. Hermite, E. J. Paterson and C. F. Cooper. Dated November 12. 11d. The object of the invention is to provide an efficient apparatus for the purpose mentioned, in which apparatus the proper circulation of the solution is ensured in such manner that it is thoroughly and efficiently submitted to electric action, there being also provided means for keeping the elements free from deposit and thereby further ensuring the proper and economical production of the electrolised solution. The claims are 7 in number.

14757. "An improved dynamo-electric machine." W. Lahmeyer. Dated November 13. 8d. Relates to dynamo machines, and particularly to the arrangement and construction of the iron portions thereof. The claims are 2 in number.

14765. "Improvements in dynamo-electric machines and electro-motors." C. Lever. Dated November 15. 8d. Claims:—1. In dynamo-electric or electro-dynamic machines the application of pole pieces having annular grooves or corrugations in their inner surfaces in combination with armatures formed or coiled correspondingly to rotate in the said pole pieces, substantially as set forth. 2. In a dynamo-electric or electro-dynamic machine an armature formed with teeth or projections of different lengths in the radial direction, in combination with pole pieces having grooves of correspondingly different depths wherein the said teeth revolve, substantially as and for the purpose set forth. 3. The construction of armatures and pole pieces described with reference to the drawings.

15075. "Improvements in combined portable or traction engines and dynamo-electrical machines." T. L. Aveling. Dated November 19. 11d. Claims:—1. Mounting a dynamo-electrical machine upon a horizontal bed above the top of the crank shaft of a portable or traction engine, the crank shaft of which is above the top of the steam boiler, and driving the dynamo by gearing from the crank shaft. 2. The construction of a combined portable or traction engine and dynamo-electrical machine, substantially as described and illustrated in the drawings.

15094. "Improvements in holders or supports for incandescent electric lamps." J. H. Holmes. Dated November 20. 8d. Claim:—In a holder for an incandescent electric lamp of the type which has the two connecting loops projecting from one end of the glass bulb, the improvements consisting of the combination with the holder and its two connecting hooks of a spring or springs so arranged, that the pressure exerted upon the lamp for the purpose of forcing the loops of the lamp into good electrical contact with the hooks of the holder, is applied at a point on that portion of the lamp situated between the loops, so that the pressure is divided equally, or nearly so, between the two pairs of hooks and loops, substantially in the manner described.

15165. "Improvements in the manufacture of incandescent electric lamps." W. Maxwell. Dated November 22. 8d. Claims:—1. In the manufacture of incandescent electric lamps, baking or carbonising the mounts of the filaments or the junctions of the illuminating conductors with the leading wires, by heat imparted to them from an adjacent electrically heated conductor within a closed case, substantially as described. 2. Exhausting incandescent electric lamps within airtight cases or receivers, and sealing their stems by the heat of an adjacent electrically heated conductor, substantially as described. 3. For maintaining low and constant the temperature of the mercurial apparatus used for exhausting electric lamps, causing the mercury to circulate through a refrigerating tube or chamber. 4. Connecting the parts of mercurial exhausting apparatus for electric lamps by inverted syphons or their equivalents, wherein mercury acts as a seal to prevent admission of air. 5. The herein-described method of purifying at a reduced pressure, and regulated temperature gaseous fluid to charge an electric lamp, and of introducing it to the lamp through an inverted syphon or its equivalent, in which mercury forms a seal against admission of air.

15545. "Improvements in and relating to the transformation and distribution of electric energy and appliances therefor." R. Dick and R. Kennedy. Dated November 29. 8d. Claims:—1. The described system for the transformation and distribution of electric energy, comprising a generator or generators of alternating currents of low potential and large volume combined with a main transformer or transformers, which transform the low potential alternating currents into currents of high potential, in the primary circuit, and one or more induction apparatus, substantially as set forth. 2. In a system for the transformation and the distribution of electric energy, the combination of a generator or generators of alternating currents of low potential with a main transformer or transformers to reduce the volume and increase the potential of the current in the primary or main circuit which can be of any length for carrying the high potential current, one or more induction apparatus to furnish a secondary current or currents of low potential induced by the high potential primary current and translating devices in the consumption circuit, substantially as set forth. 3. In a system for the transformation and distribution of electric energy, the combination of one or more electric generators of alternating currents and secondary induction apparatus, with an intermediate main transformer or transformers having a thick short wire as the primary circuit and a thin wire as the secondary circuit, which reduce the volume and increase the potential of the electric energy passing through them to the primary or main conductors and secondary transformers, substantially as set forth.

17056. "Improvements in dynamo-electric machines." G. Kapp. Dated December 29. 8d. Claims:—In a dynamo-electric machine—1. The combination of a disc armature core composed of iron ribbon with a surrounding metal hoop having projections, and the whole being fastened together by bolts or similar fastenings. 2. The described method of making the said hoop by cutting out or similarly forming sheet metal and bending projecting portions thereof, as and for the purpose set forth. 3. The combination or arrangement and use in armature cores of iron ribbon to form one part of said cores and iron wire to form the other part thereof with a hoop or hoops separating the ribbon and wire portions, and with connecting bolts or equivalent fastenings, said hoop having projecting portions serving as lateral supports to the iron wire and for transmitting the driving force to the armature coils.

CORRESPONDENCE.

A Minimum Loss of Candle-Power.

A friend of mine in New York has sent me some particulars as to the plant and installation used for lighting the private houses of an entire district in that city. If my information is correct, one of the deductions I draw therefrom is indeed remarkable.

According to the memo. received there are 48,000 incandescent lamps to be fed. These require 12 steam engines of 250 horse-power each. Edison has divided this district into three parts. Each of these divisions require 79,000 feet of wiring. The wire is manufactured in lengths of 20 feet. These are all well tested, and those whose insulation resistance does not attain 150,000,000 ohms are thrown aside. The total insulation resistance for the district is therefore—

$$\frac{20 \times 150{,}000{,}000}{79{,}000} = 37{,}974 \text{ ohms.}$$

From this it is easy to reckon the loss or waste of candle-power :—

$$\text{E} = i^2\, w = \frac{e^2}{w} = \frac{110^2}{37{,}974} = 0{\cdot}318 \text{ volt-ampère},$$

where E = electromotive force, i = intensity of current, and w the resistance.

As an Edison lamp requires 4·5 volt-ampères per C.P., the total loss = 0·0706 C.P.

I am satisfied that no gas company possessing piping for 280,000 C.P. could prove the same good results that they only lose 0·0706 C.P.

Charles Latimer.

Primary Batteries.

Since reading Mr. Bennett's letter in your issue of December 9th, I have made some researches into the dates of the respective patents, and I find :—

1. That the date of the patent for the oxide of copper battery was June 25th, 1881, anterior, I believe, to Mr. Bennett's English patent, which at that time was not published.

2. That Mr. Bennett is not the first, nor even the second, who employed soda or potash as exciting liquid in batteries, as I find that this was done by Faraday about 1800 [?], who used both zinc and potash in a battery. In 1880 Mons. Emile Reynier patented a battery, the elements of which were zinc, soda, and sulphate of copper.

3. Mr. Bennett's battery may have *on an open circuit*, an electromotive force superior to that of an oxide of copper battery, but in working, it immediately falls considerably lower.

Now, as regards the recovery of zinc oxide from exhausted caustic potash or soda solution. I was not responsible for the statement that Mr. Nursey made respecting the claim of Mr. J. Berger Spence, although I have an idea that Mr. Spence did make some improvements in this process, but the idea was not new then, as Mr. Reynier patented a process considerably before this, in which he claimed to obtain oxide of zinc from the zincate of potassium of a battery. I do not think, therefore, that the *coincidence* (?) that Mr. Bennett draws attention to is very remarkable, because the specification he mentions that was filed (No. 1,464, of 1882), was merely a rider to the orignal patent.

Hugh A. Fergusson.

December 22nd, 1887.

In reference to your paragraph *re* Disher's battery, I think you will find that each cell holds three gallons at least ; if they are the cells I sold him they do so. Whether they are filled or not I cannot say. I have not seen the battery, but I offered Mr. Disher to supply him with all material required and allow him to put up a set of cells in a locked up room at my works and to take periodical readings of the E.M.F. and current in a proper way. He showed me the report signed by Mr. Prince, and I at once concluded that the current was measured by removing the lamp at the times stated and short-circuiting through the ammeter. I think from what Mr. Disher says that the battery is worth further investigation, but with the information already to hand it is impossible to form any definite conclusion.

J. W. King.

December 27th, 1887.

Bogus Electrical Belts.

In response to your invitation, I think that I can throw more than "a glimmer of light" upon the operations of some of the so-called medical electricians who are just now reaping golden grain where they have sown nothing but chaff.

I have examined several "electrical" belts, and I am in a position to state, without the least fear of contradiction from professional men, that a greater system of fraud has not been practised on the public for many years equal to the electropathic belt and "electric generator" swindle of the present day.

The charlatan medical electrician owes his security to the total ignorance of the majority of mankind of the elementary principles of electrical science, and to the assistance of newspaper proprietors, who become bats and moles when a good paying advertiser comes across their path. Sick persons, like drowning men, catch at straws, and when they find the journals which profess to be guided by purely Christian principles aiding the advertisers in their supposed Samaritan-like missions, it is no matter for surprise that thousands of sufferers nibble at the baits so skilfully prepared for them.

I send you with this letter *a thing*—I cannot give it a name—which was sold by one of the "electrical" quacks, who is reputed to be making six thousand per annum out of such appliances, to a gentleman who left it with me in order that I might exhibit it as a warning to others who might be tempted to test the "virtues" of this much-belauded panacea.

The learned man, who does not know the difference between a condenser and a siphon recorder, advised the patient to spend about £9 in sateen and crinoline steel, assuring him that those substances would effect a speedy cure. The said patent was too wide awake to part with £9 before he had tried a less expensive appliance, and he was satisfied with the expenditure of thirty-five shillings.

Finding that he derived no benefit from the *thing*—worn according to directions, *outside* his underclothing—he sought the advice of an eminent specialist in London, who prescribed electricity from a powerful continuous current battery, and since the case has been properly treated the patient has made rapid progress towards recovery.

With your permission I will in your next issue give you a faithful account of the management of one of the largest electrical quack establishments in this country, letting the profession and the public into the secret of how an unscrupulous and ignorant person can spend twenty thousand a year and realise a large income out of—what ? A beautiful and useful invention ? No ! Out of strips of sateen and dry discs of zinc and copper !

I also enclose you an "electric generator," supposed to cure several severe forms of disease. Perhaps you will kindly examine the "generator" and report thereon.

William Lynd, *M.S.T.E., F.R.M.S.*

A Proposed Ammeter.

As you ask my opinion on Mr. Moore's proposed ammeter on my principle, I regret to say that I do not think it will work, for the following reasons among others :—

1. The expansion would not be fully shown on the moving end, most of it being taken up in enlarging the spirals.

2. The power absorbed would be excessive for an ammeter.

3. The reading would be arrived at too slowly with the conductor in one piece.

The reason why I have not brought out an ammeter on the expansion principle is, that I did not think it was wanted. At any rate we did not want it. Now, however, that alternating currents are coming in, I am getting one out.

Perhaps in this connection I may be allowed to state that the experimental failure Mr. Siemens exhibited the other night, which he appeared to think anticipated my invention, could not possibly have worked as a current measurer.

1. Because the strip heated was apparently not even enclosed.

2. Because it certainly was not compensated.

P. Cardew.

Chatham, *December 26th*, 1887.

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